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ROYAL AIRCRAFT ESTABLISHMENT  
TECHNICAL REPORT No. 65019

**TABLE OF THE  
ARTIFICIAL EARTH  
SATELLITES LAUNCHED  
IN 1957-64**

by

D. G. King-Hele

Eileen Quinn

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SUMMARY

All known artificial satellites launched before 1 January 1965 are listed chronologically. Lifetimes, weights, dimensions and orbital details are given for instrumented satellites and their final-stage rockets. Other fragments from satellites are listed without these details. The methods used in compiling the Table are described. Many improvements have been made since the previous issue.

*1. Satellites, Earth, Artificial -  
Launching (1957-64).*

Departmental Reference: Space 89



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1 INTRODUCTION

In 1958 the Royal Aircraft Establishment began issuing a Table of artificial satellites, giving lifetimes, weights, dimensions and orbits of all known satellites. Regular issues of this Table have continued, and an extensively revised version, incorporating about a thousand improvements and an index, was distributed in January 1965. This version, slightly amended, forms the basis of the present Report.

Table 1 below gives the number of successful satellite launchings each year and the number of resulting pieces in orbit - instrumented satellites (often with spent rockets attached), separated rockets, and other detectable fragments. Table 1 also gives a similar breakdown of the pieces still in orbit on 1 January 1965.

Table 1  
Census of satellites

Year	1957	1958	1959	1960	1961	1962	1963	1964	Total
Launchings	2	6	11	18	35	68	55	87	282
Resulting pieces	Instrumented satellites	2	6	11	20	40	74	74	329
		1	2	3	10	13	35	28	138
		2	3	1	20	236	81	65	488
	Total	5	11	15	50	289	190	167	955
Decayed	5	8	10	22	66	141	87	117	456
Still in orbit	Instrumented satellites	-	2	3	10	11	21	32	132
		-	1	2	6	3	14	12	61
		-	-	-	12	209	14	36	306
	Total	0	3	5	28	223	49	80	499



Until 1962 the number of successful launchings in each year was approximately equal to the total number in all preceding years. The number  $N$  of launchings in year  $n$  of the Space Age, with 1957 as year 1, was given by

$$N \approx 1.1 \times 2^n \quad (1 \leq n \leq 6) ,$$

with a maximum error in  $N$  of 2. Since 1962 this agreeably simple law has failed, and for the past three years the number of launchings has varied between 55 and 87.

## 2 GUIDE TO TABLE 2

The detailed information about the individual satellites is collected in Table 2, which follows page 10 of this Report. The data given, if available, for all satellites other than fragments, are as follows.

Column 1 gives the name of the satellite and its astronomical designation.

If the name of the satellite is unknown, its launching vehicle is indicated in square brackets. Doubtful entries are indicated by question marks, here and throughout the Table.

Letters to the left of the column have the following meanings:

D denotes satellites no longer in orbit on 1 January 1965.

M denotes manned satellites.

R denotes satellites which returned to earth and were successfully recovered.

r denotes satellites carrying capsules which returned to earth and were successfully recovered.

T denotes satellites still transmitting radio signals on 31 December 1964.

For the fragments, D indicates that all the fragments have decayed; 1d indicates that one has decayed; 2d indicates that two have decayed etc.

Column 2 gives the launch date, the lifetime (actual or estimated), and the descent date (if the satellite has decayed). Descent dates after the end of 1964 are in brackets. The dates are given in days and decimals of a day U.T. Thus "1958 Apr. 14.08" means "01 hr 55 min U.T. (or G.M.T.) on 14th of April 1958".

- Column 3 gives the shape of the satellite and its mass in kilograms. Sometimes the shape defies description in a few words and the description given is only approximate ( $1 \text{ kg} = 2.205 \text{ lb}$ ).
- Column 4 gives the length and diameter of the satellite in metres (or just the diameter, for a spherical satellite). Since most satellites so far launched have been axially symmetric (or almost so), the length and diameter usually suffice to specify the size. Aerials, paddles carrying solar cells, and other components projecting from the main body are not taken into account when giving the size.  
( $1 \text{ metre} = 3.281 \text{ feet}$ .)
- Column 5 gives the date to which the orbital information in columns 6-12 applies.
- Column 6 gives the inclination  $i$  of the orbit to the equator (see Fig.1).
- Column 7 gives the nodal period of revolution, the time interval between successive northward crossings of the equator by the satellite.
- Columns 8-11 specify the size and shape of the orbit. The quantities tabulated are the semi major axis  $a$  and eccentricity  $e$ ; and the perigee and apogee heights,  $\{a(1-e) - R\}$  and  $\{a(1+e) - R\}$  respectively, where  $R$  is the earth's equatorial radius,  $6378.2 \text{ km}$ .  
( $1 \text{ km} = 0.6214 \text{ statute miles} = 3281 \text{ ft} = 0.5396 \text{ nautical miles}$ .)
- Column 12 gives the argument of perigee,  $\omega$ , defined as the angle, measured round the orbit, from the northward equatorial crossing  $N$  to the perigee  $P$ , i.e. the angle  $NCP$  in Fig.1.

The names of space vehicles which have escaped from the earth's influence and do not appear in the Table are given at the ends of the appropriate pages of the Table. Fuller details of the space vehicles can be found in Ref.1.

It should be noted that the pages of the Table are numbered independently of this introductory text. The index at the end of the Table will be found useful for locating satellites known by name but not by their international designation.

### 3 METHODS USED

#### 3.1 Difficulties

The chief difficulty in compiling Table 2 is the lack of information about the size, shape and weight of the majority of the satellites launched in the years 1962-4. Out of the 87 launchings in 1964, for example, 30 were of Cosmos,



Elektron or Polyot satellites, and (apart from the shape of the Cosmos and Elektron satellites<sup>2</sup>) no information about these satellites or their rockets seems to have been published. United States military satellites accounted for at least another 27 launchings during 1964, and no details of these satellites have been given, apart from the diameter of the Agena rockets. In contrast, full details are available of satellites launched by NASA. Our methods of combating these difficulties are outlined in section 3.4. Numerous uncertainties remain, however, and we regret the many blank entries in the Table.

### 3.2 Names and designations of satellites

The names given by the launching authorities are indicated whenever they are known. For unnamed United States Air Force satellites, the launching vehicle is given in square brackets. The name 'Midas' has been retained for all Agena-type satellites in near-polar, near-circular orbits at heights close to 3700 km, since observers find it useful to have a distinctive label for these satellites. The name 'Transit' has been given to those satellites in near-circular polar orbits at heights close to 1000 km which are believed to form a continuation of the navigation-satellite project formerly known as the Transit system.

Some of the names are given as initials only, and the meanings of these (for satellites launched in 1964) are as follows: GGSE = gravity gradient stabilization experiment; IMP = interplanetary monitoring platform; OGO = orbiting geophysical observatory; SECOR = sequential collation of range; SR = solar radiation; TRS = tetrahedron research satellite.

The international designation of each satellite launching is now satisfactorily allocated by the World Warning Agency on behalf of COSPAR. But the identification of particular pieces in a multiple launch has often depended on visual observations, since an experienced visual observer can often recognize the species of rocket or satellite he is looking at, and can usually distinguish easily between a satellite and its rocket. Small pieces which are, as far as is known, not instrumented satellites, are called fragments. The lists issued by the United Nations are helpful in identifying fragments.

### 3.3 Lifetimes

The orbits of most satellites contract slowly under the action of air drag, and the severity of the drag determines their lifetimes, which can be estimated from the rate of change of orbital period, using the theoretical formulae<sup>3-5</sup>. It is thus tacitly assumed that their orbits will suffer no major disturbances in the future - from the burning of residual propellants or impacts by meteors, etc. -



and that the satellites will not be swept up as space-rubbish. For most short-lived satellites (< 3 years life) the lifetime estimates are usually accurate to within 10%. For long-lived satellites (> 5 years life), the lifetimes are less certain, since they depend critically on solar activity, which controls the air density: it has been assumed that the average solar activity in future sunspot cycles will be the same as the average between 1959 and 1964, and that the dates of the next few sunspot maxima and minima are as predicted in Ref.6.

For some of the satellites in high-eccentricity orbits, such as Explorers 12, 14, 18, 21 and 26, OGO 1, and Elektrons 2 and 4, the lifetime depends primarily on luni-solar perturbations rather than air drag, and lifetime estimates are often rather uncertain for these satellites.

### 3.4 Weights and dimensions

The weights and dimensions of the satellites come from various sources - 'Spacewarn' telegrams, NASA Press Releases, Pravda, the satellite observing notes issued by the Radio Research Station, Slough, the International Geophysics Bulletins of the U.S. National Academy of Sciences, and other sources, including Press reports. Some indication of the accuracy of the individual weights and dimensions is given by the number of significant figures. Often it is difficult to define the 'length' of a satellite which bristles with aerials, etc, and lengths are therefore sometimes approximate.

For satellites whose weights and sizes have not been published, the following procedure can be adopted. First, the average cross-sectional area  $S$  can be approximately determined from the average brightness when observed visually; then, if the satellite is non-spherical, its length/diameter ratio can be estimated approximately from the variations in brightness. Finally the mass/area ratio  $m/s$  can be obtained from the rate of change of orbital period and the air density at perigee height. To apply this procedure to all relevant satellites would be a lengthy task, and we have used it only on small samples, assuming that all satellites of a particular type are similar.

The dimensions given in Table 2 were derived as follows. The sizes of the Cosmos and Elektron satellites and rockets have been based on the values given by Pilkington<sup>7</sup>. For the Vostok satellites the masses are known and mass/area ratios have been calculated from the rates of change of orbital period: this gives the effective cross-sectional area and hence the diameter if, as is probable, the Vostoks are stabilized with axis tangential to the orbit. For Agena rockets launched by the United States Air Force, the published diameter of 1.5m has



been given; the length of the Agena rocket alone averages about 6m, but the satellites also carry payloads, which may presumably increase the length by up to about 4m. So the lengths are given as 8m?, implying  $8 \pm 2$  m.

Once the cross-sectional area is approximately known, mass/area ratio is determined from the rate of change of orbital period, and hence values are found for the masses of the satellites. The most careful estimates of  $m/S$  which we have made are for various Cosmos satellites (and two others) and are obtained from Ref.8.

They are as follows:

<u>Satellite</u>	<u><math>m/S</math> (<math>\text{kg/m}^2</math>)</u>	<u>Satellite</u>	<u><math>m/S</math> (<math>\text{kg/m}^2</math>)</u>
Cosmos 2	190	Cosmos 38	100
" 5	150	" 39	100
" 8	220	Star-rad (Agena)	140
" 11	170	1962 $\eta$ 1	290
" 25	170		
" 26	220		
" 31	170		

All the Cosmos satellites in the first column above were in orbits of  $49^\circ$  inclination, and since the values of  $m/S$  do not depart from  $200 \text{ kg/m}^2$  by more than 25%, this value has been adopted for all  $49^\circ$  Cosmos satellites in Table 2. Several other values of  $m/S$  for Agena rockets have been calculated and generally lie fairly close to  $140 \text{ kg/m}^2$ . Similarly a number of values calculated for Cosmos rockets were close to  $70 \text{ kg/m}^2$ . The weights assigned to the various Agena and Cosmos rockets are derived from these values of  $m/S$ .

We hope that most of the weights and dimensions given with question marks are accurate to within a factor of 1.5. It seemed better to give some indication of the weights and sizes, even if approximate, than to leave blanks.

### 3.5 Orbital accuracy

Orbital information has come from many different sources. More than half of the orbits have been based on information issued in the United States Spadats/Spacetrack Bulletins, while the remainder come mainly from three sources, the Smithsonian Astrophysical Observatory, NASA and R.A.E. It is impracticable to give full references, and indeed inappropriate, since many of the orbits have been smoothed and altered whenever they appeared inconsistent, following methods described previously<sup>9</sup>.

The accuracy of the orbits varies greatly between one satellite and another, and no detailed guide can be given. Most orbits which are free of question marks, however, are believed to have an error (s.d.) of about  $0.03^\circ$  in orbital inclination, 0.02 min in period, 2 km in semi major axis, 4 km in perigee and apogee heights (for apogee heights less than 2000 km), 0.001 in eccentricity  $e$ , and perhaps  $3^\circ$  in argument of perigee (if  $e > 0.02$ ). Some orbits are much more accurate than this, and some, particularly those with eccentricity exceeding 0.2 or with very short lifetimes, may be much less accurate.

#### 4. RADIO TRANSMISSIONS

It is difficult to give precise information about radio transmissions from satellites for various reasons. Many satellites operate on command only, and the state of health of their transmitters is known only to those concerned with giving the commands. Other satellites transmit either sporadically or only when they have been in full sunlight for longer than a (variable) minimum time. Since there are so many uncertainties we have decided not to give a table of frequencies, but merely to indicate the frequencies used by various types of satellites. Details of the operating frequencies of United States non-military satellites can be found in the fortnightly NASA Satellite Situation Report.

Most scientific satellites launched by NASA operate on frequencies between 136 and 137 Mc/s: the outstanding exception is the veteran Vanguard 1, which is still transmitting while in sunlight, on 108.0 Mc/s. OGO 1 has additional frequencies near 400 Mc/s, and the Syncom communication satellites use further frequencies between 1814 and 1821 Mc/s. Satellites of the Transit and associated systems, operate either on 150 and 400 Mc/s or on the four linked frequencies 54, 162, 324 and 648 Mc/s. The Russian Cosmos satellites normally operate at frequencies near 20 Mc/s and sometimes also near 90 Mc/s.

#### ACKNOWLEDGMENTS

We are greatly indebted to the various sources mentioned in the text for making available information about the satellites. We also thank Mr. J.A. Pilkington of the London Planetarium for many helpful criticisms and suggestions on points of detail, and Mr. D. Gray of the Radio Research Station, Slough, for giving us much useful information. We have also benefited from the work of Mrs. Doreen Walker and Mrs. Janice Rees on earlier versions of the Table.



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# TABLE OF ARTIFICIAL EARTH SATELLITES

Page 1

[illegible]



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
Explorer 1 1958 $\alpha$	1958 Feb. 1.16 10 years	Cylinder 13.97 Payload 4.8	2.03 long 0.15 dia.	1958 Feb. 1.2 1960 Dec. 5.3 1963 Nov. 9.3	33.24 33.21 33.19	114.8 107.2 104.89	7830 7481 7370	356 347 344	2548 1859 1641	0.140 0.101 0.088	121 10 102
Vanguard 1 1958 $\beta$ 2	1958 Mar. 17.51 300 years	Sphere 1.47	0.16 dia.	1958 Mar. 17.5 1962 Nov. 14.5	34.25 34.25	134.18 133.80	8687 8671	650 648	3968 3938	0.191 0.190	129 85
Vanguard 1 1958 $\beta$ 1 rocket	1958 Mar. 17.51 300 years	Cylinder 23	1.2 long 0.51 dia.	1958 Mar. 17.5 1962 Dec. 5.6	34.25 34.26	138.50 138.3	8872 8864	649 642	4340 4330	0.208 0.208	129 -
Explorer 3 1958 $\gamma$	1958 Mar. 26.73 93 days 1958 June 28	Cylinder 14 Payload 5	2.03 long 0.15 dia.	1958 Mar. 26.8 1958 May 15.0 1958 June 14.1	33.38 33.35 33.33	115.7 104.8 96.8	7871 7369 6990	186 180 171	2799 1802 1052	0.166 0.110 0.063	90 70 326
Sputnik 3 1958 $\delta$ 2	1958 May 15.3 692.0 days 1960 Apr. 6.3	Cone 1327	3.76 long 1.73 dia.	1958 May 15.3 1959 Jan. 1.3 1960 Jan. 3.8 1960 Mar. 24.5	65.18 65.15 65.11 65.06	105.97 102.000 94.000 90.000	7418 7232 6849 6653	217 210 190 162	1864 1497 751 388	0.111 0.089 0.041 0.017	58 331 182 146
Sputnik 3 1958 $\delta$ 1 rocket	1958 May 15.3 202.4 days 1958 Dec. 3.7	Cylinder? 5000?	20 long?	1958 May 15.3 1958 Aug. 15.1 1958 Oct. 11.2 1958 Nov. 30.6	65.18 65.14 65.10 65.00	105.9 102.000 98.000 90.000	7415 7232 7042 6653	214 210 199 162	1860 1497 1128 388	0.111 0.089 0.066 0.017	58 26 5 339
Fragments 1958 $\delta$ 3-5											
Explorer 4 1958 $\epsilon$	1958 July 26.63 454 days 1959 Oct. 23	Cylinder 17.5 Payload 8	2.03 long 0.15 dia.	1958 July 26.7 1959 Mar. 21.0 1959 Aug. 22.0 1959 Oct. 19.5	50.3 50.25 50.25 50.25	110.18 102.37 96.05 90.0	7616 7252 6950 6656	263 257 239 204	2213 1490 906 351	0.128 0.085 0.048 0.011	50 60 252 120
Atlas 1958 $\zeta$	1958 Dec. 18.96 33.6 days 1959 Jan. 21.6	Cylinder 3900 Payload 70	25 long 3.0 dia	1958 Dec. 19.0 1959 Jan. 1.8 1959 Jan. 17.0	32.3 32.3 32.3	101.47 98.12 92.7	7213 7053 6792	185 181 169	1484 1169 658	0.090 0.070 0.036	130 249 37

Space vehicles: Pioneer 1, 1958 $\eta$ ; Pioneer 3, 1958  $\theta$

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal perio- d (min)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
Vanguard 2 1959 α1	1959 Feb. 17.67 150 years	Sphere 9.8	0.51 dia.	1959 Feb. 17.7 1962 Nov. 13.0	32.88 32.87	125.7 125.25	8318 8298	559 559	3320 3281	0.166 0.164	135 143
Vanguard 2 1959 α2 rocket	1959 Feb. 17.67 150 years	Cylinder 23	1.2 long 0.51 dia.	1959 Feb. 17.7 1962 Dec. 5.6	32.92 32.90	130.0 129.5	8506 8484	563 562	3693 3650	0.184 0.182	135 -
D Discoverer 1 1959 β	1959 Feb. 28.91 5 days? 1959 Mar. 5?	Cone-cylinder 618	6 long 1.5 dia.	1959 Feb. 28	89.7	96?	6943?	1637	968?	0.058?	-
D Discoverer 2 1959 γ	1959 Apr. 13.89 13 days 1959 Apr. 26.6?	Cone-cylinder 1st day 743, then 650	6 long 1.5 dia.	1959 Apr. 13.9 1959 Apr. 24.6	89.9 89.9	90.4 88.9	6671 6597	239 199	346 238	0.008 0.003	160 96
D Explorer 6 1959 δ1	1959 Aug. 7.60 23 months? 1961 July?	Spheroid + 4 vanes 64	Spheroid 0.66 dia. 0.74 long	1959 Aug. 7.6 1959 Oct. 26.0 1959 Dec. 19.2	47.0 47.0 47.0	765 760 754	27710 27590 27450	245 244 237	42400 42200 41900	0.761 0.760 0.759	35 53 65
D Explorer 6 1959 δ2 rocket	1959 Aug. 7.60 23 months? 1961 July?	Cylinder 24	1.47 long 0.46 dia.	Orbit: similar to 1959 δ1							
D Discoverer 5 1959 ε1	1959 Aug. 13.79 46 days 1959 Sep. 28	Cone-cylinder 1st day 781, then 640	6 long 1.5 dia.	1959 Aug. 13.8 1959 Sep. 9.1 1959 Sep. 23.4	80.0 80.0 80.0	94.19 92.00 90.00	6856 6749 6651	217 209 193	759 533 353	0.038 0.024 0.012	157 70 22
D Discoverer 5 1959 ε2 capsule	1959 Aug. 13.79 547 days 1961 Feb. 11	Paraboloid 140	0.6 long 0.9 dia.	1960 Feb. 15.1 1960 Dec. 2.3 1961 Jan. 31.3	78.94 78.94 78.94	104.27 94.45 90.68	7337 6869 6685	218 202 180	1700 779 434	0.101 0.042 0.019	47 320 124

Continued on page 4



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
D Discoverer 6 1959 Z	1959 Aug. 19.81 62.0 days 1959 Oct. 20.8	Cone-cylinder 1st day 783, then 640	6 long 1.5 dia.	1959 Aug. 19.9 1959 Sep. 28.2 1959 Oct. 12.7	84.0 84.0 84.0	95.27 92.00 90.00	6908 6749 6651	212 196 186	848 547 359	0.046 0.026 0.013	143 360 297
Vanguard 3 1959 η	1959 Sep. 18.22 300 years	Rocket-sphere- rod 45 Payload 23	2.5 long 0.51 dia.	1959 Sep. 18.3 1961 Apr. 26.0 1963 Dec. 10.0	33.35 33.34 33.34	130.0 129.75 129.74	8506 8495 8493	512 511 510	3744 3723 3720	0.190 0.189 0.189	133 112 119
D Lunik 3 1959 θ	1959 Oct. 4.1 177 days? 1960 Mar 29?	Ellipsoid 278.5	1.32 long 1.19 dia.	1959 Oct. 18.7 1959 Dec. 22.5	73.8 82.9	22700 23300	264800 265900	40300 15700	476500 507400	0.824 0.903	182 186
Explorer 7 1959 ρ	1959 Oct. 13.65 70 years	Double cone 41.5	0.76 long 0.76 dia.	1959 Oct. 13.7 1962 Jan. 14.0 1963 Oct. 20.3	50.31 50.31 50.30	101.28 101.12 101.12	7200 7193 7192	556 556 555	1088 1074 1073	0.037 0.036 0.036	55 337 10
Explorer 7 1959 ρ <sub>2</sub> rocket	1959 Oct. 13.65 30 years	Cylinder 6	1.73 long 0.15 dia.	1959 Oct. 13.7 1962 Jan. 27.0 1964 Aug. 26.8	50.30 50.30 50.30	101.25 100.92 100.82	7199 7183 7180	554 553 551	1087 1057 1054	0.037 0.035 0.035	56 29 15
D Discoverer 7 1959 κ	1959 Nov. 7.85 19.0 days 1959 Nov. 26.8	Cone-cylinder 1st day 794, then 660	6 long 1.5 dia.	1959 Nov. 7.9 1959 Nov. 15.6 1959 Nov. 20.8	81.64 81.6 81.6	94.70 92.9 91.5	6881 6793 6725	159 157 152	847 673 542	0.050 0.038 0.029	165 138 120
D Discoverer 8 1959 λ	1959 Nov. 20.81 108.2 days 1960 Mar. 8.05	Cone cylinder 1st day 795, then 660	6 long 1.5 dia.	1959 Nov. 20.9 1960 Jan. 15.5 1960 Feb. 29.5	80.65 80.6 80.6	103.72 98.00 92.00	7311 7040 6749	187 176 162	1679 1147 580	0.102 0.069 0.031	156 356 206

Space vehicles: Lunik 1, 1959 μ; Pioneer 4, 1959 ν; Lunik 2, 1959 ξ

A rocket separated from Lunik 3, but its orbit is not known

Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m.)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km.)	Perigee height (km.)	Apogee height (km.)	Orbital eccen- tricity	Argument of perigee (deg.)
Tiros 1	1960 Apr. 1.49 60 years	Cylinder 120	0.48 long 1.07 dia.	1960 Apr. 1.5 1964 Apr. 14.3	48.4 48.37	99.16 99.11	7100 7098	693 691	750 749	0.004 0.004	115 80
Tiros 1 rocket	1960 Apr. 1.49 25 years	Cylinder 23	1.50 long 0.46 dia.	1960 Apr. 1.5 1962 Feb. 26.2	48.41 48.38	99.15 99.06	7099 7095	693 689	750 745	0.004 0.004	115 113
Fragments 1960 $\beta$ 3-4											
Transit 1B	1960 Apr. 13.50 7 years	Sphere 121	0.91 dia.	1960 Apr. 13.5 1961 June 23.7 1963 Nov. 20.6 1964 Aug. 17.8	51.28 51.28 51.25 51.23	95.81 94.94 94.10 93.85	6939 6897 6854 6844	373 367 356 349	748 670 596 582	0.027 0.022 0.017 0.017	261 28 22 306
Transit 1B rocket	1960 Apr. 13.50 491.7 days 1961 Aug. 18.19	Cylinder 600	5.3 long 1.40 dia.	1960 Apr. 13.5 1960 Dec. 8.6 1961 June 16.8	51.25 51.25 51.25	95.25 93.21 91.05	6912 6813 6707	319 285 255	748 584 403	0.031 0.022 0.011	265 64 83
Fragments 1960 $\gamma$ 3-4											
Discoverer 11 1960 $\delta$	1960 Apr. 15.85 10.88 days 1960 Apr. 26.73	Cone-cylinder 1st day 790, then 660	6 long 1.5 dia.	1960 Apr. 16.9 1960 Apr. 24.7	80.1 80.1	92.16 89.75	6757 6639	170 161	589 360	0.031 0.015	150 121

Space vehicle: Pioneer 5, 1960  $\alpha$ 

Continued on page 6



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
D Sputnik 4 1960 E 1	1960 May 15.00 844.41 days 1962 Sep. 5.41	Cylinder? 2040? Payload 1477	6 long? 1.6 dia?	1960 May 19.0 1961 June 29.4 1962 Jan. 27.5 1962 Aug. 5.8	65.02 65.02 65.02 64.95	94.25 92.53 91.44 89.50	6861 6777 6724 6628	290 284 272 224	675 514 420 277	0.028 0.017 0.011 0.004	87 270 183 94
D Sputnik 4 1960 E 2 rocket	1960 May 15.00 63.82 days 1960 July 17.82	Cylinder? 2000?	10 long? 2 dia?	1960 May 15.0 1960 June 6.8 1960 July 15.5	64.89 64.89 64.89	91.25 90.79 88.69	6714 6692 6588	318 299 206	355 329 215	0.002 0.002 0.0005	63 53 37
Sputnik 4 1960 E 3 cabin	1960 May 15.00 5 years	Cylinder? 2500	5 long? 2 dia?	1960 May 19.0 1961 June 25.3 1962 Nov. 25.8 1964 Aug. 20.9	65.0 65.0 64.98 64.98	94.27 93.35 92.41 91.07	6862 6817 6771 6706	278 275 271 267	689 602 515 388	0.030 0.024 0.018 0.009	82 286 49 142
D Fragments 1960 E 4-9											
Midas 2 1960 Z 1	1960 May 24.73 20 years	Cylinder 2300	7 long 1.5 dia.	1960 May 24.8 1963 Dec. 9.0	33.0 33.0	94.44 94.15	6876 6867	484 474	511 504	0.002 0.002	136 110
D Midas 2 1960 Z 2 nose-cap	1960 May 24.73 194.5 days 1960 Dec. 5.3	-	-	1960 May 24.8 1960 Oct. 9.5 1960 Dec. 2.6	33.00 33.00 33.00	94.44 93.02 89.79	6876 6807 6649	484 422 271	511 436 271	0.002 0.001 0	136 46

The designation of the nine pieces of Sputnik 4 is that adopted in the United States. Russian and British prediction centres referred to Sputnik 4 as E2 and the rocket as E1. Between 1960 May 15.0 and May 19.0 satellites 1960 E1 and 1960 E3 to 9 were one piece, whose orbit was similar to that of 1960 E2.

Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km.)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
Transit 2A 1960η 1	1960 June 22.25 150 years	Sphere 101	0.91 dia.	1960 June 22.3 1962 Nov. 6.8	66.69 66.68	101.66 101.63	7216 7214	628 627	1047 1045	0.029 0.029	236 340
Greb 1 1960η 2	1960 June 22.25 80 years	Sphere 19	0.51 dia.	1960 June 22.3 1962 June 3.0	66.69 66.69	101.66 101.61	7216 7211	614 612	1061 1054	0.031 0.031	236 90
Transit 2A 1960η 3 rocket	1960 June 22.25 80 years	Cylinder 450	5.3 long 1.40 dia.	1960 June 22.3 1961 June 27.6 1963 Mar. 25.2	66.7 66.66 66.66	101.37 101.42 101.41	7202 7203 7201	615 615 614	1032 1034 1031	0.029 0.029 0.029	235 333 243
Fragments 1960η 4-5											
Discoverer 13 1960 θ	1960 Aug. 10.86 95.97 days 1960 Nov. 14.83	Cone-cylinder 1st day 850, then 700	6 long 1.5 dia	1960 Aug. 10.9 1960 Oct. 9.9 1960 Nov. 9.4	82.85 82.85 82.85	94.04 92.00 90.00	6849 6749 6651	258 250 226	683 493 319	0.031 0.018 0.007	154 295 178
Echo 1 1960 ε 1	1960 Aug. 12.40 7 years?	Inflated sphere 75.9 initially; 62 after Jan. 1961	30 dia.	1960 Aug. 12.4 1960 Dec. 16.0 1961 June 20.0 1961 Dec. 6.0 1962 May 8 1962 Nov. 20.0 1963 Sep. 4 1964 Aug. 9.3	47.22 47.27 47.20 47.30 47.20 47.30 47.29 47.27	118.22 117.28 117.03 116.18 116.17 115.35 114.82 114.05	7982 7940 7929 7890 7890 7854 7827 7794	1524 966 1550 904 1500 942 971 917	1684 2157 1550 2120 1524 2010 1926 1915	0.010 0.075 0 0.077 0.002 <del>0.008</del> 0.061 0.064	14 59  78 275 97 264 274
Echo 1 1960 ε 2 rocket	1960 Aug. 12.40 20,000 years?	Cylinder 23	1.5 long 0.46 dia.	1960 Aug. 12.4 1963 Dec. 3.0	47.23 47.23	117.98 117.98	7972 7971	1502 1501	1685 1684	0.011 0.011	12 8
Fragments 1960 ε 3-5											



[illegible]

Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m.)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km.)	Perigee height (km.)	Apogee height (km.)	Orbital eccen- tricity	Argument of perigee (deg.)
D Discoverer 17 1960o	1960 Nov. 12.86 46.9 days 1960 Dec. 29.8	Cone-cylinder 1st 2 days 1091 then 930	8 long 1.5 dia.	1960 Nov. 12.9 1960 Dec. 13.2 1960 Dec. 25.3	81.70 81.70 81.70	96.45 95.11 90.35	6965 6804 6668	190 184 170	984 668 410	0.057 0.036 0.018	163 59 15
T Tiros 2 1960 <del>1</del> i	1960 Nov. 23.47 60 years	Cylinder 130	0.48 long 1.07 dia.	1960 Nov. 23.5 1964 Aug. 1.2	48.5 48.52	98.20 98.15	7054 7052	619 619	732 730	0.008 0.008	334 178
Tiros 2 1960 <del>1</del> 2 rocket	1960 Nov. 23.47 30 years	Cylinder 23	1.50 long 0.46 dia.	1960 Nov. 23.5 1964 Sept. 8.8	48.57 48.51	98.14 98.02	7051 7046	609 618	736 717	0.009 0.007	334 355
Fragments 1960 <del>1</del> 3-4											
D Sputnik 6 1960 <del>1</del> p 1	1960 Dec. 1.31 1 day 1960 Dec. 2	Cylinder 4563	6 long? 2 dia?	1960 Dec. 1.4	64.97	88.47	6577	166	232	0.005	60?
D Sputnik 6 1960 <del>1</del> p 2 rocket	1960 Dec. 1.31 1.6 days 1960 Dec. 2.9	Cylinder? 2000?	10 long? 2 dia?	1960 Dec. 2.8	65.00	87.29	6518	140	140	0	-
D Discoverer 18 1960 <del>1</del> σ	1960 Dec. 7.85 116 days 1961 Apr. 2	Cone-cylinder 1st 3 days 1240	8 long 1.5 dia.	1960 Dec. 7.9 1961 Feb. 5.8 1961 Mar. 29.0	81.50 81.48 81.48	93.66 92.0 89.49	6830 6749 6626	243 233 205	661 510 291	0.031 0.021 0.006	164 312 121
D Discoverer 19 1960 <del>1</del> τ	1960 Dec. 20.86 33.2 days 1961 Jan. 23.1	Cone-cylinder 1060	8 long 1.5 dia.	1960 Dec. 20.9 1961 Jan. 16.6 1961 Jan. 19.1	83.40 83.40 83.40	93.00 90.0 89.55	6798 6651 6629	209 186 178	631 359 324	0.031 0.013 0.011	173 75 62



[illegible]

Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m.)	Date of orbital determination	Orbital inclination (deg.)	Nodal period (min.)	Semi major axis (km.)	Perigee height (km.)	Apogee height (km.)	Orbital eccentricity	Argument of perigee (deg.)
D Explorer 9 1961 δ 1	1961 Feb. 16.55 1148.2 days 1964 Apr. 9.8	Inflated sphere 6.63	3.66 dia.	1961 Feb. 16.6 1961 Dec. 19.0 1963 Jan. 1.0 1963 Dec. 7.9	38.86 38.82 38.86 38.95	118.28 118.04 117.36 112.11	7986 7976 7947 7704	634 752 632 394	2583 2443 2506 2258	0.122 0.106 0.118 0.121	100 118 134 26
Explorer 9 1961 δ 2 rocket	1961 Feb. 16.55 100 years	Cylinder 24	1.83 long 0.46 dia.	1961 Feb. 16.6	38.85	118.4	7992	639	2589	0.122	100
1d Fragments 1961 δ 3-4											
D Discoverer 20 1961 ε 1	1961 Feb. 17.85 525.9 days 1962 July 28.7	Cone-cylinder 1st 4 days 1110 then 980	8 long 1.5 dia.	1961 Feb. 17.9 1962 Jan. 27.2 1962 July 12.4	80.91 80.84 80.82	95.41 92.78 89.91	6915 6787 6641	288 267 223	786 552 303	0.036 0.021 0.006	125 36 158
D Fragments 1961 ε 2-4											
D Discoverer 21 1961 ζ	1961 Feb. 18.95 426.0 days 1962 Apr. 20.9	Cone-cylinder 1100?	8 long 1.5 dia.	1961 Feb. 19.0 1961 Dec. 17.5 1962 Apr. 9.8	80.74 80.68 80.64	97.85 93.49 90.19	7033 6822 6656	240 239 212	1069 649 344	0.059 0.030 0.010	141 244 198
D Transit 3B-Lofti 1 1961 η	1961 Feb. 22.16 36.38 days 1961 Mar. 30.54	Cylinder 600	5.16 long 1.40 dia.	1961 Feb. 22.2 1961 Mar. 26.0	28.38 28.38	96.22 90.67	6963 6693	167 147	1002 482	0.060 0.025	29 29
D Sputnik 9 1961 θ 1 R	1961 Mar. 9.27 0.1 day 1961 Mar. 9.4	Cone-cylinder 4700	9 long? 3 dia?	1961 Mar. 9.3	64.93	88.6	6584	173	239	0.005	-
D Sputnik 9 1961 θ 2 rocket	1961 Mar. 9.27 1.1 days 1961 Mar. 10.4	Cylinder? -	-	1961 Mar. 9.6	64.9	88.2	6564	173	199	0.002	25
D Fragments 1961 θ 3-4											



Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m.)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km.)	Perigee height (km.)	Apogee height (km.)	Orbital eccen- tricity	Argument of perigee (deg.)
D R Sputnik 10	1961 1 1 1961 Mar. 25.25 0.1 day 1961 Mar. 25.3	Cone-cylinder 4695	9 long? 3 dia?	1961 Mar. 25.3	64.9	88.42	6575	164	230	0.005	-
D Sputnik 10 rocket	1961 1 2 1961 Mar. 25.25 1.7 days 1961 Mar. 26.9	Cylinder? -	-	1961 Mar. 25.9	65.0	87.8	6544	140	192	0.004	42
D Fragment	1961 1 3										
D? Explorer 10	1961 1 1 1961 Mar. 25.64	Cylind.-sphere 35	2.72 long 0.48 dia.	1961 Mar. 25.7	33	5013	97050	221	181100	0.932	-
D Discoverer 23	1961 1 1 1961 Apr. 8.75 373.1 days 1962 Apr. 16.9	Cone-cylinder 950?	8 long 1.5 dia.	1961 Apr. 9.0 1961 July 2.4 1962 Jan. 18.6	82.31 82.31 82.26	94.09 93.52 91.68	6851 6823 6734	295 295 268	651 595 443	0.026 0.022 0.013	168 227 224
D Discoverer 23	1961 1 2 1961 Apr. 8.75 409.4 days 1962 May 23.2	Paraboloid -	0.6 long 0.9 dia.	1961 Apr. 24.9 1962 Feb. 2.5 1962 May 8.5	81.94 81.88 81.82	101.49 95.03 90.04	7206 6897 6648	208 194 180	1448 843 359	0.086 0.047 0.013	112 290 307
D Discoverer 23	1961 1 3 1961 Apr. 8.75 154.8 days 1961 Sept. 10.6	Frustum -	0.6 long? 0.9 dia.?	1961 Apr. 24.9 1961 July 4.8 1961 Aug. 29.8	81.94 81.94 81.87	101.13 97.19 91.96	7189 7001 6747	200 196 187	1422 1050 551	0.085 0.061 0.027	111 249 53

A rocket is believed to have separated from Explorer 10.

	Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m.)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km.)	Perigee height (km.)	Apogee height (km.)	Orbital eccen- tricity	Argument of perigee (deg.)
D R M	Vostok 1 1961 $\mu$ 1	1961 Apr. 12.25 108 min. 1961 Apr. 12.33	Cone-cylinder 4725	9 long? 3 dia?	1961 Apr. 12.3	64.95	89.34	6620	169	315	0.011	-
D	Vostok 1 1961 $\mu$ 2 rocket	1961 Apr. 12.25 4.2 days 1961 Apr. 16.5	Cylinder? -	-	1961 Apr. 12.6	65.07	89.3	6618	161	320	0.012	100
	Explorer 11 1961 $\nu$	1961 Apr. 27.59 150 years	Cylinder 43	2.26 long 0.38 dia.	1961 Apr. 27.6	28.80	107.84	7512	487	1779	0.086	119
D r	Discoverer 25 1961 $\xi$ 1	1961 June 16.96 25 days? 1961 July 12?	Cone-cylinder 1000?	8 long 1.5 dia.	1961 June 17.1 1961 July 11.3	82.11 82.11	90.87 88.29	6694 6567	222 175	409 201	0.014 0.002	178 84
D	Fragment 1961 $\xi$ 2											
T	Transit 4A 1961 $\phi$ 1	1961 June 29.18 600 years	Cylinder 79	0.79 long 1.09 dia.	1961 June 29.2	66.81	103.82	7317	881	998	0.008	319
	Greb 3-Injun 1 1961 $\phi$ 2	1961 June 29.18 900 years	Sphere-cylinder 25-16	0.51 dia. sphere	1961 June 29.2	66.82	103.85	7319	882	999	0.008	318
3d	Fragments 1961 $\phi$ 3-206											
D r	Discoverer 26 1961 $\pi$	1961 July 7.98 150.4 days 1961 Dec. 5.4	Cone-cylinder 1000?	8 long 1.5 dia	1961 July 8.3 1961 Sept. 18.4 1961 Nov. 21.3	82.94 82.94 82.94	95.02 93.14 90.39	6896 6805 6670	228 223 212	808 631 372	0.042 0.030 0.012	160 260 18



Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m.)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km.)	Perigee height (km.)	Apogee height (km.)	Orbital eccen- tricity	Argument of perigee (deg.)
T Tiros 3	1961 p 1 1961 July 12.43 100 years	Cylinder 129	0.48 long 1.07 dia.	1961 July 12.5	47.90	100.33	7156	735	820	0.006	42
Tiros 3 rocket	1961 p 2 1961 July 12.43 50 years	Cylinder 23	1.50 long 0.46 dia.	1961 July 12.5	47.9	100.31	7154	740	812	0.005	42
Fragments 1961 p 3-4											
Midas 3	1961 σ 1 1961 July 12.68 100,000 years?	Cylinder 1600	9 long 1.5 dia.	1961 July 12.7 1962 Oct. 12.9	91.2 91.19	161.54 161.52	9824 9820	3358 3340	3534 3544	0.009 0.010	240 95
Midas 3 nose-cap	1961 σ 2 1961 July 12.68 13.20 days 1961 July 25.88	-	-	1961 July 15.4 1961 July 18.5	90.80 90.80	117.25 109.7	7934 7589	138 134	2974 2289	0.179 0.142	164 -
Fragments 1961 σ 3-4											
D R M Vostok 2	1961 τ 1 1961 Aug. 6.25 25.3 hours 1961 Aug. 7.30	Cone-cylinder 4730	9 long? 3 dia?	1961 Aug. 6.3	64.93	88.46	6577	166	232	0.005	-
Vostok 2 rocket	1961 τ 2 1961 Aug. 6.25 3 days 1961 Aug. 9	Cylinder?	-	Orbit similar to Vostok 2							
Explorer 12	1961 v 1961 Aug. 16.14 10 years?	Ostagon + 4 vanes 38	0.15 long 0.66 dia.	1961 Sep. 22.5 1962 Jan. 30.5	33.1 33.43	1591 1587.3	45190 45086	314 790	77310 76620	0.852 0.841	- -
Ranger 1	1961 φ 1 1961 Aug. 23.46 6.89 days 1961 Aug. 30.35	Cylinder 306	3.5 long 1.5 dia.	1961 Aug. 24.1 1961 Aug. 29.5	32.9 32.9	90.64 88.9	6691 6605	179 174	446 280	0.020 0.008	206 -
Ranger 1 rocket	1961 φ 2 1961 Aug. 23.46 10.68 days 1961 Sep. 3.14	Cylinder 1000?	8 long? 1.5 dia	1961 Aug. 24.1 1961 Aug. 29.5	32.93 32.93	90.71 89.7	6694 6644	175 173	456 359	0.021 0.014	206 -

A rocket is believed to have separated from Explorer 12.

Year of launch 1961, continued

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Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m.)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km.)	Perigee height (km.)	Apogee height (km.)	Orbital eccen- tricity	Argument of perigee (deg.)
D Explorer 13 1961 X	1961 Aug. 25.81 2.3 days 1961 Aug. 28.1	Cylinder 86	1.93 long 0.61 dia.	1961 Aug. 26.8	37.7	97.5	7023	125	1164	0.074	-
D Discoverer 29 1961 ψ	1961 Aug. 30.8 10.2 days 1961 Sep. 9.98	Cone-cylinder 1000?	8 long 1.5 dia.	1961 Aug. 31.3	82.14	91.51	6725	152	542	0.029	83
D Discoverer 30 1961 ω 1	1961 Sep. 12.83 90.1 days 1961 Dec. 11.9	Cone-cylinder 1000?	8 long 1.5 dia.	1961 Sep. 13.6 1961 Nov. 21.5 1961 Dec. 5.5	82.66 82.66 82.66	92.40 90.4 89.4	6769 6671 6621	235 213 204	546 373 283	0.023 0.012 0.006	142 - -
D Fragments 1961 ω 2-3											
D Mercury 4 1961 α α 1	1961 Sep. 13.59 109 min. 1961 Sep. 13.66	Cone-frustum 1200	2.90 long 1.83 dia.	1961 Sep. 13.6	32.8	88.4	6580	156	248	0.007	-
D Mercury 4 1961 α α 2 rocket	1961 Sep. 13.59 5 hours 1961 Sep. 13.8	Cylinder 3400	20 long 3.0 dia.	1961 Sep. 13.6	32.85	87.3	6526	147	147	0	
D Discoverer 31 1961 α β	1961 Sep. 17.88 38.57 days 1961 Oct. 26.45	Cone-cylinder 1100?	8 long 1.5 dia.	1961 Sep. 21.0 1961 Oct. 10.5	82.70 82.7	90.86 90.0	6693 6651	235 220	396 326	0.012 0.008	136 -
D Discoverer 32 1961 α γ 1	1961 Oct. 13.81 30.6 days 1961 Nov. 13.4	Cone-cylinder 1000?	8 long 1.5 dia.	1961 Oct. 14.1 1961 Nov. 10.3	81.69 81.64	90.84 88.93	6692 6598	234 207	395 233	0.012 0.002	158 60
D Fragments 1961 α γ 2-3											

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Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m.)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km.)	Perigee height (km.)	Apogee height (km.)	Orbital eccen- tricity	Argument of perigee (deg.)
Midas 4	1961 Oct. 21.58 100,000 years?	Cylinder 1800?	9 long? 1.5 dia.	1961 Nov. 2.0	95.89	166.01	10004	3496	3756	0.013	18
1d Fragments 1961αδ 2-4											
D Discoverer 34 1961αε1	1961 Nov. 5.83 396.4 days 1962 Dec. 7.2	Cone-cylinder 1100?	8 long 1.5 dia.	1961 Nov. 6.1 1962 June 5.3 1962 Nov. 24.7	82.52 82.46 82.46	97.12 94.40 89.91	6998 6863 6642	227 220 196	1011 750 332	0.056 0.039 0.010	152 149 246
D Fragments 1961αε 2-5											
D Discoverer 35 1961αζ1	1961 Nov. 15.89 17.9 days 1961 Dec. 3.8	Cone-cylinder 1000?	8 long 1.5 dia.	1961 Nov. 21.5 1961 Dec. 2.5	81.63 81.63	89.7 88.2	6636 6562	238 177	278 190	0.003 0.001	- -
D Fragment 1961αζ2											
Transit 4B 1961αη1	1961 Nov. 15.93 1000 years	Cylinder 90	0.79 long 1.09 dia.	1961 Nov. 16.6	32.43	105.63	7408	956	1104	0.010	329
Traac 1961αη2	1961 Nov. 15.93 800 years	"Door-knob" 90	1.3 long? 1.09 dia.	1961 Nov. 21.5	32.43	105.64	7409	941	1119	0.012	-
Transit 4B 1961αη3 rocket	1961 Nov. 15.93 500 years?	Cylinder 450?	5.3 long 1.4 dia.	1961 Nov. 21.5	32.41	105.49	7402	942	1105	0.011	-

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Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclination (deg.)	Nodal period (min.)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccentricity	Argument of perigee (deg.)
T Tiros 4	1962 Feb. 8.52 100 years	Cylinder 129	0.48 long 1.07 dia.	1962 Feb. 13.5	48.30	100.31	7154	712	840	0.009	-
Tiros 4 rocket	1962 Feb. 8.52 50 years	Cylinder 23	1.50 long 0.46 dia.	1962 Feb. 13.5 1963 Dec. 15.5	48.13 48.13	101.4 101.3	7206 7201	706 703	951 943	0.017 0.017	-
Fragments 1962 β 3-4											-
D Mercury 6 (Friendship 7)	1962 Feb. 20.62 296 min. 1962 Feb. 20.82	Cone-crustum 1352	2.90 long 1.83 dia.	1962 Feb. 20.7	32.54	88.6	6590	159	265	0.008	80
D Mercury 6 rocket	1962 Feb. 20.62 1 day 1962 Feb. 21	Cylinder 3400	20 long 3.0 dia.	1962 Feb. 20.8	32.57	88.0	6560	156	208	0.004	84
D Discoverer 37? 1962 δ r?	1962 Feb. 21 16 days 1962 Mar. 9	Cylinder 1000?	8 long? 1.5 dia.	1962 Feb. 21	81.97	90.0	6649	167	374	0.016	-
D Discoverer 38 1962 ε 1 r	1962 Feb. 27.91 21 days 1962 Mar. 21	Cone-cylinder 1000?	8 long 1.5 dia.	1962 Mar. 9.8 1962 Mar. 13.5	82.23 82.23	90.04 89.7	6653 6636	208 208	341 308	0.010 0.008	98 -
D Fragments 1962 ε 2-4											-
T? Oso 1	1962 Mar. 7.67 30 years	Nonagonal box 200	0.94 long 1.12 dia.	1962 Mar. 13.5	32.85	95.89	6942	556	570	0.001	-
Oso 1 rocket	1962 Mar. 7.67 15 years	Cylinder 24	1.8 long 0.46 dia.	1962 Mar. 18.3	32.83	95.98	6950	544	600	0.004	203

Space vehicle: Ranger 3, 1962 α

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclination (deg.)	Nodal period (min.)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccentricity	Argument of perigee (deg.)
D [Atlas Agena B] 1962 η 1	1962 Mar. 7.8 457.1 days 1963 Jun. 7.9	- 500?	1.5 dia?	1962 Mar. 13.5 1963 Jan. 5.7 1963 May 28.7	90.89 90.87 90.86	93.9 91.57 88.85	6842 6723 6600	251 223 189	676 467 255	0.031 0.018 0.005	- 2 104
D Agena rocket 1962 η 3	1962 Mar. 7.8 240.6 days 1962 Nov. 3.4	Cylinder 1000?	6 long? 1.5 dia.	1962 May 1.6 1962 July 6.6 1962 Oct. 24.6	90.87 90.87 90.87	93.3 92.4 89.6	6813 6769 6630	250 228 209	618 553 294	0.027 0.024 0.006	- - -
D Fragment 1962 η 2											
D Cosmos 1 (Sputnik 11) 1962 θ 1	1962 Mar. 16.50 70 days 1962 May 25	Ellipsoid 400?	1.8 long? 1.2 dia?	1962 Mar. 16.6 1962 May 1.6 1962 May 25	49.00 48.99 48.99	96.35 92.7 87.9	6964 6788 6552	204 194 173	967 626 175	0.055 0.032 0	104 309 -
D Cosmos 1 rocket 1962 θ 2	1962 Mar. 16.50 94 days 1962 June 18	Cylinder? 1500?	10 long? 2 dia?	1962 Mar. 19.8 1962 May 17.5 1962 June 5.6	49.0 49.0 49.0	96.10 92.6 91.0	6953 6783 6705	206 202 186	943 609 468	0.053 0.030 0.021	118 - 108
D Cosmos 2 (Sputnik 12) 1962 ι 1	1962 Apr. 6.72 499.3 days 1963 Aug. 20.0	Ellipsoid 400?	1.8 long? 1.2 dia?	1962 Apr. 7 1962 Dec. 22.0 1963 Jul. 28.3	48.97 48.94 48.90	102.25 97.17 90.39	7246 7006 6686	202 195 187	1535 1060 428	0.092 0.062 0.018	- 49 306
D Cosmos 2 rocket 1962 ι 2	1962 Apr. 6.72 182.7 days 1962 Oct. 6.4	Cylinder? 1500?	10 long? 2 dia?	1962 Apr. 10.1 1962 July 16.4 1962 Oct. 3.1	48.94 48.91 48.85	101.90 96.69 90.02	7230 6982 6652	215 191 169	1488 1015 379	0.088 0.059 0.016	119 147 141
Midas 5? 1962 κ 1	1962 Apr. 9.66 100,000 years?	Cylinder 2000?	9 long? 1.5 dia.	1962 May 1.6	86.68	153.03	9476	2814	3382	0.030	-
1d Fragments 1962 κ 2-4											
D [Thor Agena B] 1962 λ 1	1962 Apr. 18 40 days 1962 May 28	Cylinder 1500?	8 long? 1.5 dia.	1962 May 1.6 1962 May 17.5	73.48 73.45	90.9 89.5	6699 6626	200 198	441 297	0.018 0.007	- -
D Fragments 1962 λ 2-4											

Space vehicle: Ranger 4, 1962 μ

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[illegible]

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
D [Thor Agena B] 1962-01	1962 May 15.82 560.0 days 1963 Nov. 26.8	Cylinder 1500?	8 long? 1.5 dia	1962 May 20.6 1962 Dec. 11.7 1963 Oct. 17.5	82.33 82.33 82.32	94.02 93.03 90.55	6848 6795 6680	305 287 248	634 546 355	0.024 0.019 0.008	148 131 56
D Fragments 1962-03											
D Mercury 7 1962-01	1962 May 24.53 296 min. 1962 May 24.74	Cone-frustum 1349	2.90 long 1.83 dia.	1962 May 24.6	32.5	88.5	6585	154	260	0.008	-
D Mercury 7 1962-02	1962 May 24.53 1 day 1962 May 25	Cylinder 3400	20 long 3.0 dia	Orbit similar to 1962-01							
D Cosmos 5 1962-01	1962 May 28.13 339.6 days 1963 May 2.7	Ellipsoid 400?	1.8 long? 1.2 dia?	1962 May 28.2 1962 Nov. 28.8 1963 Mar. 15.1	49.06 49.00 48.96	102.75 97.41 92.89	7267 7019 6808	190 187 184	1587 1095 712	0.096 0.065 0.039	112 104 205
D Cosmos 5 1962-02	1962 May 28.13 201 days 1962 Dec. 15	Cylinder? 1500?	10 long? 2 dia?	1962 May 29.5 1962 Sept 4.3 1962 Nov. 24.5	49.1 49.01 48.98	102.67 99.06 92.69	7266 7096 6792	205 194 181	1571 1242 647	0.094 0.074 0.034	116 129 113
D [Thor Agena B] 1962-01	1962 May 30.02 12 days 1962 June 11	Cylinder 1500?	8 long? 1.5 dia.	1962 June 5.5 1962 June 8.3	74.10 74.10	89.7 88.96	6637 6599	199 195	319 248	0.009 0.004	- 1
D Fragment 1962-02											

continued on page 22



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclination (deg)	Nodal period (min)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccentricity	Argument of perigee (deg.)
D [Thor Agena B] 1962 X1	1962 June 2.03 26.9 days 1962 June 28.9	Cylinder 1500?	8 long? 1.5 dia.	1962 June 5.5 1962 June 19.5 1962 June 25.4	74.26 74.25 74.25	90.5 89.60 88.87	6676 6632 6596	211 193 188	385 315 247	0.013 0.009 0.004	- 91 75
D Oscar 2 1962 X2	1962 June 2.03 19 days 1962 June 21	Rectangular box? 5	0.30 long? 0.25 wide?	1962 June 2.9 1962 June 15.6	74.27 74.27	90.55 89.3	6679 6617	207 193	394 285	0.014 0.007	133 -
D Fragment 1962 X3											
D [Atlas Agena B] 1962 Y	1962 June 17 1 day 1962 June 18	Cylinder 2000?	8 long? 1.5 dia.	Orbit unknown							
D [Thor Agena B] 1962 W1	1962 June 18.85 498.1 days 1963 Oct. 30.0	Cylinder 1500?	8 long? 1.5 dia.	1962 June 22.6 1962 Dec. 17.7 1963 Oct. 26.8	82.14 82.12 82.10	92.4 91.86 88.69	6769 6738 6583	370 344 198	411 375 211	0.003 0.002 0.001	- 50 336
D Fragments 1962 W2-3											
T Tiros 5 1962 A A.1	1962 June 19.51 100 years	Cylinder 129	0.56 long 1.07 dia.	1962 July 13.4	58.08	100.44	7159	588	974	0.027	121
Tiros 5 rocket 1962 A A.2	1962 June 19.51 50 years	Cylinder 23	1.50 long 0.46 dia.	1962 July 17.5	58.08	100.4	7157	586	972	0.027	-
Fragments 1962 A A.3-4											
D [Thor Agena B] 1962 A B	1962 June 23.02 14.7 days 1962 July 7.7	Cylinder 1500?	8 long? 1.5 dia.	1962 June 27.5 1962 July 3.9	75.09 75.09	89.58 88.82	6631 6593	213 209	293 222	0.006 0.001	140 121

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
D [Thor Agena D] 1962 α γ	1962 June 28.05 78 days 1962 Sept 14	Cylinder 1500?	8 long? 1.5 dia.	1962 July 3.5 1962 Aug. 20.4 1962 Sept 8.4	76.04 76.04 76.01	93.6 91.24 89.48	6828 6713 6619	211 187 176	689 482 305	0.035 0.022 0.010	- 358 297
D Cosmos 6 1962 α δ 1 (Sputnik 16)	1962 June 30.67 70 days 1962 Sept 8	Ellipsoid 400?	1.8 long? 1.2 dia?	1962 July 1.0 1962 Aug. 9.5 1962 Aug. 26.1	48.96 48.96 48.95	90.54 89.91 89.46	6683 6652 6628	264 247 241	344 300 258	0.006 0.004 0.001	72 258 358
D Cosmos 6 1962 α δ 2 rocket	1962 June 30.67 38.5 days 1962 Aug. 8.2	Cylinder? 1500?	10 long? 2 dia?	1962 July 1.0 1962 July 21.5 1962 Aug. 1.6	48.97 48.97 48.95	90.49 89.86 89.22	6680 6649 6617	262 244 226	342 297 253	0.006 0.004 0.002	72 150 -
Telstar 1 1962 α ε 1	1962 July 10.36 10,000 years	Sphere 77	0.86 dia.	1962 July 10.4	44.79	157.65	9670	952	5632	0.242	165
Telstar 1 1962 α ε 2 rocket	1962 July 10.36 3000 years	Cylinder 23	1.5 long 0.46 dia.	1962 July 17.5	44.78	157.53	9664	947	5625	0.242	176
D [Atlas Agena B] 1962 α ζ 1	1962 July 18.87 9 days 1962 July 27	Cylinder 2000?	8 long? 1.5 dia.	1962 July 22.2 1962 July 24.6	96.12 96.12	88.73 88.5	6588 6577	184 179	236 218	0.004 0.003	217 -
D Fragment 1962 α ζ 2											
D [Thor Agena E] 1962 α η	1962 July 21.04 24 days 1962 Aug. 14	Cylinder 1500?	8 long? 1.5 dia.	1962 July 21.2 1962 Aug. 4.1 1962 Aug. 12.8	70.29 70.29 70.29	90.42 89.69 88.42	6673 6637 6574	208 192 176	381 325 216	0.013 0.010 0.003	155 139 122
D [Thor Agena B] 1962 α θ	1962 July 28.02 27 days 1962 Aug. 24	Cylinder 1500?	8 long? 1.5 dia.	1962 July 28.2 1962 Aug. 16.6 1962 Aug. 21.7	71.09 71.09 71.09	90.64 89.69 88.93	6684 6637 6599	225 192 186	386 325 254	0.012 0.010 0.005	155 119 109



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
D Cosmos 7 R? (Sputnik 17)	1962 July 28.39 4 days 1962 Aug. 1	-	-	1962 July 30.3	64.95	90.08	6655	197	356	0.012	48
D Cosmos 7 rocket	1962 July 28.39 24 days 1962 Aug. 21	Cylinder? 1500?	10 long? 2 dia?	1962 July 30.3 1962 Aug. 12.1 1962 Aug. 18.8	64.96 64.92 64.91	90.00 89.38 88.56	6653 6622 6582	208 198 171	341 291 237	0.010 0.007 0.005	67 58 52
D Fragments 1962 Aug. 3-4											
D [Thor Agena D] 1962 Aug. 1	1962 Aug. 2.02 24 days 1962 Aug. 26	Cylinder 1500?	8 long? 1.5 dia.	1962 Aug. 3.2 1962 Aug. 17.7 1962 Aug. 24.8	82.25 82.25 82.25	90.77 89.85 88.64	6689 6644 6584	204 199 179	418 332 232	0.016 0.010 0.004	149 99 71
D Fragment 1962 Aug. 2											
D [Atlas Agena B] 1962 Aug. 7	1962 Aug. 5.75 1 day 1962 Aug. 6	Cylinder 2000?	8 long? 1.5 dia.	1962 Aug. 6.0	96.30	88.62	6583	205	205	0	
D Vostok 3 R M	1962 Aug. 11.35 3.94 days 1962 Aug. 15.29	Cone-cylinder 4730	9 long? 3 dia.?	1962 Aug. 11.5 1962 Aug. 12.8 1962 Aug. 13.8 1962 Aug. 15.2	64.98 64.98 64.98 64.98	88.33 88.24 88.13 87.97	6570 6566 6561 6553	166 162 158 155	218 214 207 194	0.004 0.004 0.004 0.003	- - - -
D Vostok 3 rocket	1962 Aug. 11.35 2.7 days 1962 Aug. 14.1	Cylinder? -	-	1962 Aug. 13.0	64.82	87.5	6529	151	151	0	
D Vostok 4 R M	1962 Aug. 12.33 2.96 days 1962 Aug. 15.29	Cone-cylinder 4730	9 long? 3 dia.?	1962 Aug. 12.4 1962 Aug. 13.8 1962 Aug. 14.8	64.95 64.95 64.95	88.39 88.26 88.18	6573 6567 6563	169 163 159	222 215 211	0.004 0.004 0.004	- - -
D Vostok 4 rocket	1962 Aug. 12.33 2.4 days 1962 Aug. 14.7	Cylinder?	-	1962 Aug. 13.0	64.80	88.38	6573	169	221	0.004	141

Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m)	Date of orbital determination	Orbital inclination (deg.)	Nodal period (min)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccentricity	Argument of perigee (deg)
D Cosmos 8	1962 Aug. 18.21 364.7 days 1963 Aug. 17.92	Ellipsoid? 400?	1.8 long? 1.2 dia?	1962 Aug. 18.5 1963 Jan. 14.1 1963 Aug. 14.9	48.97 48.96 48.93	92.93 91.94 88.26	6799 6751 6571	244 238 173	598 508 213	0.026 0.020 0.003	121 92 45
D Cosmos 8 rocket	1962 Aug. 18.21 123.3 days 1962 Dec. 19.5	Cylinder? 1500?	10 long? 2 dia?	1962 Aug. 19.7 1962 Oct. 14.7 1962 Nov. 29.0	48.98 48.98 48.96	92.92 91.95 90.50	6799 6752 6681	251 245 232	591 502 373	0.025 0.019 0.011	132 31 246
[Blue Scout]	1962 Aug. 23.49 20 years	- 60?	-	1962 Aug. 23.5 1963 Dec. 31.4	98.66 98.66	99.62 99.58	7117 7111	620 613	858 852	0.017 0.017	240 183
Altair rocket	1962 Aug. 23.49 20 years	Cylinder 24	1.5 long 0.46 dia	1962 Oct. 10.5	98.68	99.6	7115	615	858	0.017	-
Fragments	1962 Aug. 25.12 3 days 1962 Aug. 28	-	-	1962 Aug. 25.9 1962 Aug. 27.0	64.88 64.88	88.73 88.37	6590 6572	173 168	252 221	0.006 0.004	90 -
D Sputnik 19 rocket?	1962 Aug. 25.12 8 days 1962 Sep. 2	-	-	1962 Aug. 25.9 1962 Aug. 31.0	64.89 64.89	89.38 88.63	6623 6585	178 161	311 253	0.010 0.007	90 -
D Fragments	1962 Aug. 29.05 12 days 1962 Sep. 10	Cylinder 1500?	8 long? 1.5 dia.	1962 Aug. 30.1 1962 Sep. 7.4	65.21 65.21	90.38 89.09	6672 6608	187 170	400 289	0.016 0.009	182 -
D [Thor Agena D]	1962 Sep. 1 5 days 1962 Sep. 6	-	-	1962 Sep. 1	65?	90?					
D Sputnik 20?	1962 Sep. 1 5 days 1962 Sep. 6	-	-								
D Fragments	1962 Aug. 23.49 20 years										



[illegible]

Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km.)	Perigee height (km.)	Apogee height (km.)	Orbital eccen- tricity	Argument of perigee (deg.)
T Alouette	1962 $\beta\alpha$ 1 2,000 years	Oblate spheroid 144.7	0.86 long 1.07 dia	1962 Sep. 29.7	80.46	105.52	7392	996	1032	0.002	8
Alouette rocket	1962 $\beta\alpha$ 2 2,000 years	Cylinder 1000?	1.6 long 1.5 dia	1962 Sep. 29.7	80.47	105.47	7393	1008	1023	0.001	336
Fragments 1962 $\beta\alpha$ 3-4											
D [Thor Agena D]	1962 $\beta\beta$ 14 days 1962 Oct. 14	Cylinder 1500?	8 long? 1.5 dia	1962 Oct. 1.5 1962 Oct. 10.7	65.40 65.40	90.30 89.08	6668 6607	203 196	376 262	0.013 0.005	172 166
Explorer 14	1962 $\beta\gamma$ 1 10 years?	Octagon + 4 vanes 40	1.30 long 0.74 dia	1962 Oct. 10.6 1963 Dec. 27.5	32.95 42.31	2185 2184.6	55784 55772	281 2558	98530 96229	0.881 0.840	150 191
Explorer 14 rocket	1962 $\beta\gamma$ 2 10 years?	Cylinder 24	1.5 long 0.46 dia	Orbit similar to 1962 $\beta\gamma$ 1							
Mercury 8 (Sigma 7)	1962 Oct. 3.51 9.22 hours 1962 Oct. 3.89	Cone-frustum 1370	2.90 long 1.83 dia	1962 Oct. 3.6	32.55	88.75	6597	153	285	0.010	74
Mercury 8 rocket	1962 Oct. 3.51 1 day 1962 Oct. 4	Cylinder 3400	20 long 3 dia	1962 Oct. 3.6	32.55	88.67	6594	156	275	0.009	74
[Thor Agena B]	1962 Oct. 9.79 37.3 days 1962 Nov. 16.1	Cylinder 1500?	8 long? 1.5 dia	1962 Oct. 10.8 1962 Oct. 20.7 1962 Nov. 14.6	81.96 81.96 81.96	90.96 90.71 88.37	6698 6680 6569	213 209 170	427 395 212	0.016 0.014 0.003	58 20 286
Cosmos 10	1962 Oct. 17.39 4 days 1962 Oct. 21	-	-	1962 Oct. 17.4	65.00	90.2	6660	197	367	0.013	-
R?											
Cosmos 10 rocket	1962 Oct. 17.39 19 days 1962 Nov. 5	Cylinder? 1500?	10 long? 2 dia?	1962 Oct. 21.7	64.90	89.06	6606	196	260	0.005	61

Space vehicle: Ranger 5, 1962  $\beta\eta$



Name	Launch date, lifetime and descent date	Shape and weight (kg.)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km.)	Perigee height (km.)	Apogee height (km.)	Orbital eccen- tricity	Argument of perigee (deg.)
D Cosmos 11	1962 Oct. 20.16 575.9 days 1964 May 18.1	Ellipsoid 400?	1.8 long? 1.2 dia?	1962 Oct. 28.2 1963 Dec. 30.4	48.97 48.95	95.95 92.03	6946 6762	234 234	901 533	0.048 0.022	148 249
D Cosmos 11 rocket	1962 Oct. 20.16 228.8 days 1963 June 6.0	Cylinder? 1500?	10 long? 2 dia?	1962 Oct. 29.2 1962 Dec. 27.6 1963 May 21.3	48.95 48.93 48.93	95.77 94.63 90.22	6937 6883 6679	233 226 221	885 784 381	0.047 0.041 0.012	154 50 351
D Sputnik 22?	1962 Oct. 24 5 days 1962 Oct. 29	-	-	1962 Oct. 25	65?	90?					
D Fragments	1962 Oct. 2-24										
Star-rad	1962 Oct. 26.68 4 1/2 years	Cylinder 1500?	9 long? 1.5 dia	1962 Oct. 29.5 1964 Aug. 19.5	71.41 71.27	147.87 132.72	9262 8619	198 201	5570 4275	0.290 0.236	156 303
Explorer 15	1962 Oct. 27.97 100 years	Octagon + 4 vanes 45.2	1.20 long 0.74 dia	1962 Oct. 28.0 1964 Aug. 9.7	18.02 18.02	315.20 311.44	15353 15247	313 300	17640 17438	0.564 0.562	137 196
Explorer 15 rocket	1962 Oct. 27.97 100 years	Cylinder 24	1.5 long 0.46 dia	Initial orbit similar to 1962 Oct. 27.97							
Anna 1B	1962 Oct. 31.34 5000 years	Spheroid 161	0.91 long 1.22 dia	1962 Oct. 31.8	50.14	107.84	7508	1077	1182	0.007	202
Anna 1B rocket	1962 Oct. 31.34 2000 years	Cylinder 450?	5.3 long 1.4 dia	1962 Nov. 7.6	50.13	107.53	7492	1069	1159	0.006	-
Mars 1	1962 Nov. 1	Cylinder 833.5	3.3 long 1.1 dia	Initial earth-satellite orbit similar to 1962 Oct. 31.8							
Sputnik 23?	1962 Nov. 1 1 day 1962 Nov. 2.3	-	-	1962 Nov. 1	65	90?		200?	300?		-
Sputnik 23 rocket?	1962 Nov. 1 2 days 1962 Nov. 3	-	-	Initial earth-satellite orbit similar to 1962 Oct. 31.8							

Year of launch 1962, continued

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
D Sputnik 24? 1962 $\beta \xi 1$	1962 Nov. 4.65 1 day 1962 Nov. 5	-	-	Initial orbit similar to 1962 $\beta \xi 3$							
D Sputnik 24 1962 $\beta \xi 3$ rocket?	1962 Nov. 4.65 76 days 1963 Jan. 19	Cylinder? 1500?	10 long? 2 dia?	1962 Nov. 5.4 1962 Dec. 1.3	64.7 64.7	92.42 91.49	6772 6726	197 153	590 503	0.029 0.023	353 355
D Fragments 1962 $\beta \xi 2, 4, 5$											
D [Thor Agena B] 1962 $\beta o$	1962 Nov. 5.93 27 days 1962 Dec. 3	Cylinder 1500?	8 long? 1.5 dia	1962 Nov. 7.7 1962 Nov. 29.2	74.98 74.97	90.71 89.02	6687 6603	208 185	409 265	0.015 0.006	150 106
D [Atlas Agena B] 1962 $\beta \pi$	1962 Nov. 11.85 1 day 1962 Nov. 12	Cylinder 2000?	8 long? 1.5 dia	1962 Nov. 12.0	96.00	88.65	6584	206	206	0	-
D [Thor Agena B] 1962 $\beta \rho$	1962 Nov. 24.92 18 days 1962 Dec. 13	Cylinder 1500?	8 long? 1.5 dia	1962 Nov. 27.0 1962 Dec. 4.3	65.14 65.13	89.92 89.63	6649 6635	204 204	337 310	0.010 0.008	145 150
D [Thor Agena D] 1962 $\beta \sigma$	1962 Dec. 4.90 3 days 1962 Dec. 8	Cylinder 1500?	8 long? 1.5 dia	1962 Dec. 5.1 1962 Dec. 7.0	65.1 65.1	89.16 88.40	6612 6574	194 169	273 222	0.006 0.004	154 223

Continued on Page 30



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
[Thor Agena D] 1962 $\beta$ $\tau$ 1	1962 Dec. 13.17 4 years	-	-	1962 Dec. 17.0 1964 Aug. 21.3	70.36 70.36	116.26 109.75	7887 7593	231 228	2786 2202	0.162 0.130	145 157
Injun 3 1962 $\beta$ $\tau$ 2	1962 Dec. 13.17 7 years	Sphere 48	0.61 dia	1962 Dec. 13.7 1964 Jul. 3.2	70.38 70.34	116.32 112.95	7888 7740	235 236	2785 2484	0.162 0.145	149 233
[Thor Agena D] 1962 $\beta$ $\tau$ 3	1962 Dec. 13.17 200.8 days 1963 July 2.0	-	-	1962 Dec. 16.5 1963 Mar. 9.7 1963 Apr. 21.1	70.33 70.32 70.28	115.89 108.94 101.83	7871 7564 7222	226 225 223	2763 2147 1465	0.161 0.127 0.086	146 53 353
[Thor Agena D] 1962 $\beta$ $\tau$ 4	1962 Dec. 13.17 3½ years	-	-	1962 Dec. 16.5 1964 Aug. 18.8	70.34 70.31	116.24 106.25	7886 7431	231 227	2784 1878	0.162 0.111	146 136
[Thor Agena D] 1962 $\beta$ $\tau$ 5	1962 Dec. 13.17 4 years	-	-	1962 Dec. 19.5 1964 Aug. 9.5	70.34 70.31	116.22 109.73	7885 7592	229 226	2785 2200	0.162 0.130	143 170
Agena rocket 1962 $\beta$ $\tau$ 6	1962 Dec. 13.17 6 years	Cylinder 1200?	6 long? 1.5 dia	1962 Dec. 28.6 1964 Aug. 6.9	70.36 70.37	116.3 112.13	7889 7704	248 238	2774 2412	0.160 0.141	- 189
Relay 1 1962 $\beta$ v 1	1962 Dec. 13.98 100,000 years?	Octagonal prism 78	0.81 long 0.74 dia	1962 Dec. 14.0	47.49	185.01	10759	1322	7439	0.284	178
Relay 1 1962 $\beta$ v 2	1962 Dec. 13.98 50,000 years?	Cylinder 23	1.8 long 0.46 dia	1962 Dec. 20.0	47.45	184.71	10750	1345	7598	0.282	184
[Thor Agena D] 1962 $\beta$ $\phi$	1962 Dec. 14.89 25.0 days 1963 Jan. 8.9	Cylinder 1500?	8 long? 1.5 dia	1962 Dec. 15.8 1962 Dec. 27.8 1963 Jan. 4.5	70.97 70.95 70.95	90.46 89.85 89.08	6674 6643 6604	199 193 178	392 336 274	0.014 0.011 0.007	163 150 122

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Year of launch 1962, continued

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
Explorer 16 1962 $\beta\chi$	1962 Dec. 16.61 1000 years	Cylinder 100.8	1.93 long 0.61 dia	1962 Dec. 16.6	52.01	104.32	7344	750	1181	0.029	142
Transit 5A 1962 $\beta\psi 1$	1962 Dec. 19.06 60 years	Octagon+4 vanes + boom 61	0.50 long 0.30 dia	1962 Dec. 20.0	90.62	99.12	7090	698	725	0.002	353
Transit 5A 1962 $\beta\psi 3$ rocket	1962 Dec. 19.06 60 years	Cylinder 23	1.8 long 0.46 dia	1962 Dec. 20.7	90.74	99.11	7089	698	723	0.002	-
Fragments 1962 $\beta\psi 2.4$											
D Cosmos 12 1962 $\beta\omega 1$ R?	1962 Dec. 22.39 8 days 1962 Dec. 30	-	-	1962 Dec. 22.4	65.0	90.45	6673	198	392	0.015	-
D Cosmos 12 1962 $\beta\omega 2$ rocket	1962 Dec. 22.39 31 days 1963 Jan. 22	Cylinder? 1500?	10 long? 2 dia?	1963 Jan. 2.6	64.94	90.17	6662	197	370	0.013	-



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclination (deg.)	Nodal period (min.)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccentricity	Argument of perigee (deg.)
D Sputnik 25?	1963-01A 1963 Jan. 4.3 1 day 1963 Jan. 5	-	-	Orbit unknown							
D Fragments	1963-01B-C										
D [Thor Agena D]	1963-02A 1963 Jan. 7.88 16.3 days 1963 Jan. 24.2	Cylinder 1500?	8 long? 1.5 dia.	1963 Jan. 7.9 1963 Jan. 13.8 1963 Jan. 21.4	82.23 82.23 82.19	90.54 90.13 88.92	6680 6651 6589	205 193 168	399 353 254	0.015 0.012 0.006	178 156 126
D Fragment	1963-02B	-	-								
D [Thor Agena D]	1963-03A 1963 Jan. 16.92 7 years	Cylinder 1500?	8 long? 1.5 dia.	1963 Jan. 16.9 1964 Nov. 21.2	81.89 81.88	94.66 94.52	6874 6872	459 459	533 528	0.005 0.005	40 224
D Fragments	1963-03B-C										
Syncom 1	1963-04A 1963 Feb. 14.22 > million years	Cylinder 39	0.39 long 0.71 dia.	1963 Feb. 14.2	33.30	1425.5	41944	34392	36739	0.028	276
Syncom 1 rocket	1963-04B 1963 Feb. 14.22 100 years?	Cylinder 24	1.5 long 0.46 dia.	1963 Apr. 4.9 1963 Dec. 15.5	33.12 33.12	606.0 604.4	23753 23691	252 252	34498 34374	0.721 0.720	165 -
[Blue Scout]	1963-05A 1963 Feb. 19.69 20 years	- 60?	-	1963 Mar. 9.7	100.48	97.79	7026	505	791	0.020	289
Altair rocket	1963-05B 1963 Feb. 19.69 25 years	Cylinder 24	1.5 long 0.46 dia.	1963 Feb. 19.7	100.49	97.79	7028	510	789	0.020	340
Fragments	1963-05C-D										
D Cosmos 13	1963-06A 1963 Mar. 21.35 8 days 1963 Mar. 29	-	-	1963 Mar. 21.4	64.97	89.77	6636	192	324	0.010	65?
D Cosmos 13 rocket	1963-06B 1963 Mar. 21.35 19 days 1963 Apr. 9	Cylinder? 1500?	10 long? 2 dia?	Initial orbit similar to 1963-06A							

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min.)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
D [Thor Agena D]	1963 Apr. 1.92	Cylinder	8 long?	1963 Apr. 2.0	75.40	90.66	6683	201	408	0.015	158
	25.0 days	1500?	1.5 dia.	1963 Apr. 10.4	75.38	90.28	6661	198	367	0.013	134
Luna 4*	1963 Apr. 26.9	-	-	-	-	-	-	-	-	-	-
	1963 Apr. 2	1422	-	Initial earth-satellite orbit similar to 1963-08c	-	42,000?	400,000?	90,000?	700,000?	0.8?	-
D Sputnik 26?	1963 Apr. 2	-	-	1963 Apr. 2	65?	88?	-	-	-	-	-
	1 day	-	-	-	-	-	-	-	-	-	-
1963 Apr. 3	-	-	-	-	-	-	-	-	-	-	-
Explorer 17	1963 Apr. 3.08	Sphere	0.89 dia.	1963 Apr. 3.1	57.63	96.40	6964	255	917	0.048	49
	4 years	185	-	1964 Oct. 24.6	57.63	94.72	6885	252	762	0.037	58
D Explorer 17	1963 Apr. 3.08	Cylinder	1.5 long	1963 Apr. 3.6	57.59	96.32	6962	247	920	0.048	51
rocket	235.6 days	24	0.46 dia.	1963 May 31.6	57.59	95.12	6904	245	807	0.041	-
	1963 Nov. 24.7	-	-	-	-	-	-	-	-	-	-
D Cosmos 14	1963 Apr. 13.46	Ellipsoid	1.8 long?	1963 Apr. 13.5	48.95	92.1	6754	252	499	0.018	-
	137.6 days	400?	1.2 dia?	1963 June 2.4	48.88	91.29	6722	253	435	0.013	-
	1963 Aug. 29.1	-	-	-	-	-	-	-	-	-	-
D Cosmos 14	1963 Apr. 13.46	Cylinder?	10 long?	1963 May 1.0	48.90	91.59	6735	249	465	0.016	205
rocket	84.2 days	1500?	2 dia?	1963 June 9.0	48.90	90.64	6689	237	384	0.011	42
	1963 Jul. 6.7	-	-	-	-	-	-	-	-	-	-
D Cosmos 15	1963 Apr. 22.35	-	-	1963 Apr. 22.4	65.00	89.77	6637	160	358	0.015	-
R?	5 days	-	-	-	-	-	-	-	-	-	-
	1963 Apr. 27	-	-	-	-	-	-	-	-	-	-
D Cosmos 15	1963 Apr. 22.35	Cylinder?	10 long?	1963 Apr. 27.3	64.95	89.19	6614	170	302	0.010	58
rocket	9.5 days	1500?	2 dia?	-	-	-	-	-	-	-	-
	1963 May 1.8	-	-	-	-	-	-	-	-	-	-

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\*In the United States, Luna 4 has been designated as 1963-08B and Sputnik 26 as 1963-08A. There is also believed to be a rocket in the Luna 4 orbit.



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclination (deg)	Nodal period (min.)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccentricity	Argument of perigee (deg.)
D R? Cosmos 16	1963-12A 1963 Apr. 28.40 10 days 1963 May 8	-	-	1963 Apr. 28.4	65.02	90.4	6669	194	388	0.015	57
D Cosmos 16 rocket	1963-12B 1963 Apr. 28.40 22.3 days 1963 May 20.7	Cylinder? 1500?	10 long? 2 dia?	1963 Apr. 30.3	65.02	90.48	6674	196	396	0.015	73
T Telstar 2	1963-13A 1963 May 7.48 600,000 years?	Spheroid 79.4	0.94 long 0.86 dia.	1963 May 7.5	42.73	225.05	12267	974	10803	0.401	172
Telstar 2 rocket	1963-13B 1963 May 7.48 200,000 years?	Cylinder 24	1.52 long 0.45 dia.	1963 May 13.3	42.76	224.81	12258	989	10770	0.399	178
Midas 6?	1963-14A 1963 May 9.84 100,000 years?	Cylinder 2000?	9 long? 1.5 dia.	1963 May 12.2	87.42	166.48	10020	3604	3680	0.004	69
TRS 1A	1963-14B 1963 May 9.84 50,000 years?	Tetrahedron 0.8	0.17 side	1963 May 15.2	87.35	166.51	10021	3604	3683	0.004	69
TRS 1B	1963-14C 1963 May 9.84 50,000 years?	Tetrahedron 0.8	0.17 side	1963 May 29.2	87.42	166.47	10020	3606	3678	0.004	54
Fragments 1963-14D-H											
Needles	1963-14J 1963 May 9.84 2 to 5 years	Annulus 23	20,000 km dia.	1963 Aug 7 1964 Jan 29	87.35 87.22	166.46 166.0	10025 10007	3379 2760	3915 4497	0.027 0.087	180 349

	Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
D R M	Mercury 9 (Faith 7) 1963-15A	1963 May 15.54 1.44 days 1963 May 16.98	Cone frustum 1370	2.90 long 1.83 dia	1963 May 15.6	32.54	6592	161	267	0.008	-
D	Mercury 9 rocket 1963-15B	1963 May 15.54 0.6 days 1963 May 16.2	Cylinder 3400	20 long 3.0 dia	1963 May 15.7	32.54	6571	167	219	0.004	72
D	[Thor Agena D] 1963-16A	1963 May 18.94 8 days 1963 May 27	Cylinder 1500?	8 long? 1.5 dia	1963 May 20.4	74.54	6703	153	497	0.025	142
	Cosmos 17 1963-17A	1963 May 22.13 2 years	Ellipsoid 400?	1.8 long? 1.2 dia?	1963 May 22.2 1964 Jan. 1.9	49.0 49.0	6902 6839	260 256	788 666	0.037 0.030	107 354
D	Cosmos 17 rocket 1963-17G	1963 May 22.13 316.7 days 1964 April 2.8	Cylinder? 1500?	10 long? 2 dia?	1963 May 30.6 1964 Jan. 7.4	49.0 49.0	6891 6745	265 238	761 495	0.036 0.019	139 66
Ld	Fragments 1963-17B-F										
D R?	Cosmos 18 1963-18A	1963 May 24.45 9.0 days 1963 June 2.4	-	-	1963 May 24.5	65.0	6620	196	288	0.007	-
D	Cosmos 18 rocket 1963-18B	1963 May 24.45 14.6 days 1963 June 8.0	Cylinder? 1500?	10 long? 2 dia?	1963 May 26.9 1963 June 3.4	65.0 64.95	6629 6593	198 195	304 235	0.008 0.003	96 92
D	[Thor Agena D] 1963-19A	1963 Jun 13.00 29.1 days 1963 Jul 12.1	Cylinder 1500?	8 long? 1.5 dia	1963 Jun 14.4 1963 Jul 10.0	81.87 81.82	6684 6577	192 173	419 225	0.017 0.004	135 36



[illegible]

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclination (deg.)	Nodal period (min)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccentricity	Argument of perigee (deg.)
D R M Vostok 6	1963-23A 1963 June 16.40 2.95 days 1963 June 19.35	Cone-cylinder 4713	9 long? 3 dia?	1963 June 16.4 1963 June 17.5	65.09 65.09	88.34 88.2	6571 6566	168 164	218 212	0.004 0.004	80 -
D Vostok 6 rocket	1963-23B 1963 June 16.40 1.7 days? 1963 June 18.1?	Cylinder? -	-	1963 June 16.8	65.08	88.38	6571	163	223	0.005	76
T Tiros 7	1963-24A 1963 June 19.41 50 years	Cylinder 133	0.56 long 1.07 dia	1963 June 19.5	58.23	97.40	7013	621	649	0.002	17
Tiros 7 rocket	1963-24B 1963 June 19.41 20 years	Cylinder 23	1.50 long 0.46 dia	1963 July 23.14	58.21	97.35	7011	612	650	0.003	56
Fragments 1963-24C-D											
D [Thor Agena D]	1963-25A 1963 June 27.03 29.7 days 1963 July 26.7	Cylinder 1500?	8 long? 1.5 dia	1963 June 29.5 1963 July 23.8	81.6 81.6	90.5 88.8	6674 6583	196 168	396 243	0.015 0.006	147 36
Hitch-hiker 1	1963-25B 1963 June 27.03 100 years	Octagon 79.8 23 payload	0.3 long 0.9 dia	1963 July 20.1 1963 Dec. 22.9	82.1 82.1	132.55 132.48	8607 8604	333 333	4132 4119	0.221 0.220	350 78
GRS	1963-26A 1963 June 28.83 15 years	Cylinder 99.3	2.54 long 0.592 dia	1963 June 29.6 1963 Oct. 21.4	49.74 49.72	102.1 102.04	7239 7238	411 414	1311 1305	0.062 0.061	136 174
[Thor Agena B]	1963-27A 1963 June 29.94 7 years	Cylinder 1500?	8 long? 1.5 dia	1963 July 10.0 1964 Oct. 12.6	82.3 82.32	94.84 94.74	6888 6884	484 483	536 528	0.004 0.003	336 164
D Fragments	1963-27B-C										



[illegible]

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
D Cosmos 19	1963-33A 1963 Aug 6.25 237.07 days 1964 Mar 30.32	Ellipsoid 400?	1.8 long? 1.2 dia?	1963 Aug 15.6 1963 Oct 10.7 1964 Jan 7.0	49.01 49.01 49.00	92.11 91.71 90.89	6760 6740 6704	267 261 252	497 463 400	0.017 0.015 0.011	153 99 98
D Cosmos 19 rocket	1963-33B 1963 Aug 6.25 124.8 days 1963 Dec 9.0	Cylinder? 1500?	10 long? 2 dia?	1963 Aug 15.5 1963 Oct 21.1 1963 Dec 3.7	49.00 49.00 48.94	92.00 91.07 89.58	6756 6712 6626	267 253 235	489 415 261	0.016 0.012 0.002	- 109 299
D [Thor Agena D]	1963-34A 1963 Aug 25.02 18.6 days 1963 Sep 12.6	Cylinder 1500?	8 long? 1.5 dia	1963 Sep 7.3	75.01	89.4	6618	161	320	0.012	104
D Fragment	1963-34B										
D [Thor Agena D]	1963-35A 1963 Aug 29.80 69.7 days 1963 Nov 7.5	Cylinder	8 long? 1.5 dia	1963 Sep 3.0 1963 Oct 22.1	81.89 81.86	90.80 90.00	6686 6652	292 261	324 287	0.002 0.002	151 32
D [Thor Agena D]	1963-35B 1963 Aug 29.80 24-30 days 1963 Sep 23-29	-	-	1963 Sep 2.7	81.89	92.07	6749	310	431	0.009	261
D Fragments [Atlas Agena D]	1963-35C-D 1963-36A 1963 Sep 6.81 7.05 days 1963 Sep 13.86	Cylinder 2000?	8 long? 1.5 dia	1963 Sep 10.8	94.37	89.06	6594	168	263	0.007	103
D Fragments	1963-36B-F										
D [Thor Agena D]	1963-37A 1963 Sep 23.95 18.2 days 1963 Oct 12.14	Cylinder 1500?	8 long? 1.5 dia	1963 Sep 24.1 1963 Oct 10.8	74.90 74.89	90.63 88.64	6679 6594	161 150	441 282	0.021 0.010	158 101



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
Ablesar rocket	1963-38A 1963 Sep 28.84 1000 years	Cylinder 450?	5.3 long 1.4 dia	1963 Sep 29.7	89.80	107.13	7466	1069	1107	0.003	240
T? Transit?	1963-38B 1963 Sep 28.84 1000 years?	73	-	1963 Oct 11.1	89.90	107.42	7479	1075	1127	0.003	232
T Radiation satellite	1963-38C 1963 Sep 28.84 1000 years?	- 61	-	1963 Oct 11.2	89.89	107.40	7479	1075	1126	0.003	234
Fragments [ Atlas Agena D ] (Vela 1?)	1963-38D-E 1963 Oct 17.10 >million yrs	Cylinder?	8 long? 1.5 dia?	1963 Oct 17.1	38.3	6270	113,000	102,098	111,137	0.040	-
TRS 2	1963-39B 1963 Oct 17.10 10 years?	Tetrahedron 2.0	0.2 side	1963 Oct 17.1	36.77	2329	58,240	220	103,500	0.887	153
Vela 2?	1963-39C 1963 Oct 17.10 >million yrs	Icosahedron 220	1.0 dia?	1963 Oct 19	37.8	6370	113,900	99,300	115,800	0.072	-
D Cosmos 20	1963-40A 1963 Oct 18.40 10 days 1963 Oct 28-29	-	-	1963 Oct 18.7 1963 Oct 20.7	64.90 64.90	89.53 89.51	6632 6628	205 204	302 296	0.007 0.007	32 32
D Cosmos 20 rocket	1963-40B 1963 Oct 18.40 12 days 1963 Oct 30-31	Cylinder? 1500?	10 long? 2 dia?	1963 Oct 18.4 1963 Oct 28.0	64.91 64.87	89.68 88.12	6635 6586	204 185	310 231	0.008 0.004	43 91

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
D [Atlas Agena D] 1963-41A	1963 Oct 25.79 4.0 days 1963 Oct 29.8	Cylinder? 1500?	8 long? 1.5 dia.	1963 Oct 26.0 1963 Oct 27.8	99.05 99.05	88.99 88.70	6616 6584	144 140	332 272	0.014 0.010	97 78
D [Atlas Agena D] 1963-41B	1963 Oct 25.79 3-4 days 1963 Oct 28-29	-	-	1963 Oct 27.9	99.05	88.55	6575	136	297	0.012	78
D Fragments 1963-41C-D											
D [Thor Agena D] 1963-42A	1963 Oct 29.88 83.51 days 1964 Jan 21.39	Cylinder 1500?	8 long? 1.5 dia.	1963 Nov 2.1 1963 Nov 29.4 1964 Jan 6.4	89.90 89.90 89.89	90.84 90.42 89.53	6690 6670 6623	279 275 232	345 308 258	0.005 0.002 0.002	- 250 84
D [Thor Agena D] 1963-42B	1963 Oct 29.88 18 months	-	-	1963 Oct 31.7 1964 Nov 18.5	89.99 89.97	93.35 91.83	6813 6741	285 282	585 444	0.022 0.012	32 284
D Fragment 1963-42C											
Polyot 1 1963-43A	1963 Nov 1.37 10 years	-	-	1963 Nov 1.4 1963 Nov 2.0 1964 Nov 21.5	- 58.92 58.92	94.0 102.46 102.30	6843 7268 7248	339 343 347	592 1437 1392	0.018 0.075 0.072	- 114 154
Polyot 1 1963-43B rocket	1963 Nov 1.37 3 years	Cylinder?	-	1963 Nov 5.6 1964 Nov 13.5	58.58 58.61	102.51 100.61	7257 7168	324 330	1434 1249	0.076 0.064	116 192
Fragments 1963-43C-D											
D Cosmos 21 1963-44A	1963 Nov 11.27 2.86 days 1963 Nov 14.13	-	-	1963 Nov 11.4	64.83	88.5	6577	182	216	0.003	-
D Cosmos 21 1963-44B rocket	1963 Nov 11.27 1.69 days 1963 Nov 12.96			Orbit similar to 1963-44A							



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclination (deg.)	Nodal period (min.)	Semi-major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccentricity	Argument of perigee (deg.)
D Cosmos 22	1963-45A 1963 Nov 16.45 6 days 1963 Nov 22	-	-	1963 Nov 16.5	64.93	90.3	6665	192	381	0.014	-
D Cosmos 22 rocket	1963-45B 1963 Nov 16.45 16.7 days 1963 Dec 3.2	Cylinder? 1500?	10 long? 2 dia?	1963 Nov 18.4 1963 Dec 1.1	64.86 64.84	90.14 88.06	6658 6573	189 166	369 223	0.013 0.004	33 40
T Explorer 18 (IMP 1)	1963-46A 1963 Nov 27.10 2 years?	Octagon + 4 vanes 62	0.34 long 0.74 dia.	1963 Nov 28.5 1964 Nov 9.4	33.34 36.39	5666 5600	105,282 104,488	192 3862	197,616 192,358	0.938 0.902	- 152
Explorer 18 rocket	1963-46B 1963 Nov 27.10 2 years?	Cylinder 24	1.8 long 0.46 dia.	Orbit similar to Explorer 18							
Centaur 2	1963-47A 1963 Nov 27.79 500 years	Cylinder 4620	8.6 long 3 dia.	1963 Nov 30.8	30.34	107.46	7500	544	1699	0.077	137
Fragments [Thor Agena D]	1963-48A 1963 Nov 27.88 17.3 days 1963 Dec 15.2	Cylinder 1500?	8 long? 1.5 dia.	1963 Nov 30	69.99	90.2	6658	175	386	0.016	-

## Year of launch 1963, continued

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
Ablestar rocket 1963-49A	1963 Dec 5.91 1000 years	Cylinder 450?	5.3 long 1.4 dia	1963 Dec 6.1	89.97	106.86	7458	1065	1095	0.002	308
T [Thor Ablestar] 1963-49B	1963 Dec 5.91 1000 years?	- 70?	-	1963 Dec 12.4	89.98	107.18	7468	1067	1112	0.003	327
T Transit? 1963-49C	1963 Dec 5.91 1000 years?	- 60?	-	1963 Dec 8.8	89.95	107.16	7468	1069	1111	0.003	303
Fragments 1963-49D-F											
D Cosmos 23 1963-50A	1963 Dec 13.58 104.48 days 1964 March 27.06	Ellipsoid 400?	1.8 long? 1.2 dia?	1963 Dec 13.7 1964 Jan 9.3	49.0 48.98	92.90 92.27	6805 6769	240 241	613 540	0.027 0.022	126 255
D Cosmos 23 1963-50B rocket	1963 Dec 13.58 84.37 days 1964 March 6.95	Cylinder? 1500?	10 long? 2 dia	1963 Dec 13.6 1964 Jan 12.0	49.12 48.99	92.84 92.04	6799 6757	230 230	611 527	0.028 0.022	136 268
D Fragments 1963-50C-D											
D [Atlas Agena D] 1963-51A	1963 Dec 18.91 1.28 days 1963 Dec 20.17	Cylinder 2000?	8 long? 1.5 dia	1963 Dec 19.1	97.89	88.48	6572	122	266	0.011	94
D Cosmos 24 1963-52A	1963 Dec 19.39 9 days 1963 Dec 28	-	-	1963 Dec 19.8	65.03	90.51	6676	204	391	0.014	49
D R?											
D Cosmos 24 1963-52B rocket	1963 Dec 19.39 36.1 days 1964 Jan 24.5	Cylinder? 1500?	10 long? 2 dia?	1963 Dec 21.1 1964 Jan 13.0	65.00 65.00	90.58 89.61	6679 6630	207 192	394 312	0.014 0.009	62 46

Continued on Page 44



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
Explorer 19	1963 Dec 19.78 4 years	Inflated sphere 7	3.65 dia	1963 Dec 19.8 1964 Oct 15.5	78.62 78.63	115.93 115.5	7870 7858	590 600	2394 2359	0.115 0.112	- 227
Explorer 19 rocket	1963 Dec 19.78 200 years	Cylinder 24	1.5 long 0.46 dia	1963 Dec 23.0	78.62	115.85	7867	594	2383	0.114	154
Fragments 1963-53B-E, G, H											
Tiros 8	1963 Dec 21.39 60 years	Cylinder 119	0.55 long 1.05 dia	1963 Dec 21.5	58.48	99.33	7105	691	765	0.005	123
Tiros 8 rocket	1963 Dec 21.39 30 years	Cylinder 23	1.50 long 0.46 dia	1963 Dec 29.9	58.47	99.27	7103	696	753	0.004	117
Fragments	1963-54C-D										
[Thor Agena D]	1963 Dec 21.91 18.0 days 1964 Jan 8.9	Cylinder 1500?	8 long? 1.5 dia	1963 Dec 22.3	64.94	89.96	6644	176	355	0.0135	149
[Thor Agena D]	1963 Dec 21.91 326.89 days 1964 Nov 7.80	-	-	1963 Dec 23.8 1964 Jul 26.1 1964 Nov 4.1	64.52 64.52 64.52	91.68 90.73 88.72	6733 6689 6588	321 291 203	388 331 216	0.005 0.003 0.001	89 348 307

T

D

D

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
Agna D rocket	1964 Jan 11.84 800 years	Cylinder 1000?	6 long? 1.5 dia	1964 Jan 16.3	69.91	103.47	7298	905	934	0.002	84
GGSE	1964 Jan 11.84 1000 years?	-	-	1964 Jan 16.8	69.94	103.47	7298	898	942	0.003	92
SECOR (EGRS)	1964 Jan 11.84 1500 years	Rectangular box 18	0.4 x 0.3 x 0.2	1964 Jan 16.8	69.89	103.46	7297	904	933	0.002	84
SR 5	1964 Jan 11.84 1000 years	Sphere 45	0.6 dia	1964 Jan 16.8	69.90	103.47	7298	905	934	0.002	74
[Thor Agna D] 1964-01E	1964 Jan 11.84 1000 years?	-	-	1964 Jan 21.5	69.90	103.48	7298	905	934	0.002	96
[Thor Agna D] 1964-02A	1964 Jan 19.45 300 years	Cylinder 1500?	8 long? 1.5 dia	1964 Nov 9.5	99.07	101.33	7199	792	850	0.004	169
Fragments 1964-02B-C											
Relay 2	1964 Jan 21.88 1 million years	Octagonal prism 78	0.81 long 0.74 dia	1964 Jan 22.9	46.32	194.60	11129	2091	7411	0.239	184
Relay 2 rocket	1964 Jan 21.88 1 million years	Cylinder 23	1.5 long 0.46 dia	1964 Jan 22.8	46.32	194.61	11132	2071	7437	0.241	186



Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclination (deg.)	Nodal period (min.)	Semi-major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccentricity	Argument of perigee (deg.)
Echo 2 1964-04A	1964 Jan 25.58 20 years?	Sphere 256	41 dia	1964 Jan 27.1 1964 Mar 4.9 1964 Nov 3.0	81.50 81.46 81.55	108.95 108.88 108.66	7551 7548 7541	1029 989 1148	1316 1351 1178	0.019 0.024 0.002	104 19 330
Echo 2 1964-04B rocket	1964 Jan 25.58 5000 years	Cylinder 1000?	6 long 1.5 dia	1964 Jan 27.1	81.50	108.96	7552	1030	1317	0.019	103
Fragments 1964-04C-E											
Saturn SA5 1964-05A	1964 Jan 29.68 20 months	Cylinder 17100	25.6 long 6.5 dia	1964 Jan 30.6 1964 Mar 3.1 1964 Nov 24.8	31.43 31.43 31.45	94.60 94.41 93.49	6890 6883 6830	264 264 254	760 756 650	0.036 0.035 0.029	135 105 317
Elektron 1 1964-06A	1964 Jan 30.40 200 years	Cylinder and 6 paddles	3 long? 2 dia?	1964 Jan 31.5	60.83	169.32	10138	394	7126	0.332	61
Elektron 2 1964-06B	1964 Jan 30.40 10 years?	Cone-cylinder and spire	5 long? 2 dia?	1964 Feb 5.0 1964 Nov 21.2	60.87 59.25	1356.40 1356.35	40593 40589	441 806	67988 67616	0.832 0.823	70 78
Elektron 2 1964-06D rocket	1964 Jan 30.40 10 years?	Cylinder 1500?	10 long? 2 dia?	1964 Feb 6.1 1964 Nov 24.3	60.87 59.34	1384.11 1384.00	41145 41140	411 821	69123 68702	0.835 0.825	70 77
Fragment 1964-06C											

Space Vehicle: Ranger 6, 1964-07

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
D [Thor Agena D] 1964-08A	1964 Feb 15.90 23.0 days 1964 Mar 9.9	Cylinder 1500?	8 long? 1.5 dia	1964 Feb 17.7 1964 Mar 5.5	74.95 74.95	90.86 89.5	6690 6623	179 165	444 324	0.020 0.012	147 96
D Fragment 1964-08B											
D [Atlas Agena D] 1964-09A	1964 Feb 25.79 4 days 1964 Mar 1	Cylinder 2000?	8 long? 1.5 dia	1964 Feb 26.4	95.66	88.24	6560	173	190	0.001	103
D Fragment 1964-09B											
D Cosmos 25 1964-10A	1964 Feb 27.56 267.05 days 1964 Nov 21.61	Ellipsoid 400?	1.8 long? 1.2 dia?	1964 Feb 27.7 1964 Jun 10.5 1964 Nov 7.3	49.01 48.97 49.0	92.27 91.40 89.61	6769 6725 6636	255 253 225	526 441 301	0.020 0.014 0.005	121 248 236
D Cosmos 25 1964-10B rocket	1964 Feb 27.56 111.7 days 1964 June 18.3	Cylinder? 1500?	10 long? 2 dia?	1964 Feb 28.4 1964 Jun 3.1	49.07 49.04	92.25 89.64	6768 6639	234 227	545 294	0.023 0.005	127 220
D Fragments 1964-10C-D											
[Thor Agena D] 1964-11A	1964 Feb 28.14 7 years	Cylinder 1500?	8 long? 1.5 dia	1964 Feb 29.1	82.03	94.74	6878	479	520	0.003	58
D Fragments 1964-11B-C											



[illegible]

	Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
T	Ariel 2 1964-15A	1964 Mar 27.73 4 years	Cylinder + 4 paddles 68	0.9 long 0.58 dia	1964 Mar 28.4 1964 Jul 30.4 1964 Nov 18.0	51.64 51.65 51.66	101.29 101.00 100.68	7201 7188 7172	285 285 285	1362 1335 1303	0.075 0.073 0.071	140 158 138
	Ariel 2 1964-15B rocket	1964 Mar 27.73 3 years	Cylinder 24	1.8 long 0.46 dia	1964 Mar 29.2 1964 Nov 15.5	51.67 51.64	101.27 100.4	7200 7157	282 282	1362 1275	0.075 0.069	142 -
	Fragment 1964-15C											
D	Zond 1 1964-16A launcher	1964 Apr 2.12 1.5 days 1964 Apr 3.6	-	-	1964 Apr 2.5	64.83	88.47	6578	187	213	0.002	345
D	Zond 1 1964-16B rocket?	1964 Apr 2.12 0.6 days 1964 Apr 2.7	-	-	1964 Apr 2.5	65.22	88.10	6559	122	240	0.009	139
D	Fragment 1964-16C											
D R?	Cosmos 28 1964-17A	1964 Apr 4.40 7.9 days 1964 Apr 12.3	-	-	1964 Apr 4.8	65.04	90.37	6671	213	373	0.012	45
D	Cosmos 28 1964-17B rocket	1964 Apr 4.40 28.7 days 1964 May 3.1	Cylinder? 1500?	10 long? 2 dia?	1964 Apr 4.9	65.01	90.48	6676	224	371	0.011	63
D	Fragment 1964-17C											





	Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
D	[Thor Agena D] 1964-22A	1964 Apr 27.98 28.19 days 1964 May 26.17	Cylinder 1500?	8 long? 1.5 dia	1964 May 1.1	79.93	90.77	6690	178	446	0.020	130
D R?	Cosmos 30 1964-23A	1964 May 18.41 7.90 days 1964 May 26.31	-	-	1964 May 20.3	64.87	90.25	6664	206	366	0.012	38
D	Cosmos 30 1964-23B rocket	1964 May 18.41 20.3 days 1964 June 7.7	Cylinder? 1500?	10 long? 2 dia?	1964 May 24.2	64.84	89.94	6650	205	338	0.010	24
D	[Atlas Agena D] 1964-24A	1964 May 19.81 2.9 days 1964 May 22.7	Cylinder 2000?	8 long? 1.5 dia	1964 May 20.7	101.12	89.69	6639	141	380	0.018	120
D	Saturn SA6 1964-25A	1964 May 28.71 3.31 days 1964 June 1.02	Cone-cylinder 16900	24 long 5.7 dia	1964 May 29.7	31.74	88.22	6570	179	204	0.002	122
T	Transit? [Blue Scout] 1964-26A	1964 June 4.16 200 years	- 60?	-	1964 June 5.2	90.42	103.12	7283	854	956	0.007	99
	Altair rocket 1964-26D	1964 June 4.16 200 years	Cylinder 24	1.5 long 0.46 dia	1964 June 19.2	90.45	103.13	7283	854	956	0.007	-
D	Fragments 1964-26B-C [Thor Agena D] 1964-27A	1964 June 4.96 13.94 days 1964 June 18.90	Cylinder 1500?	8 long? 1.5 dia	1964 June 7.1 1964 June 17.0	79.96 79.95	90.27 89.15	6667 6610	149 139	429 324	0.021 0.014	107 74



[illegible]

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
D [Thor Agena D ] 1964-32A	1964 June 19.97 26.81 days 1964 July 16.78	Cylinder 1500?	8 long? 1.5 dia	1964 June 21.1 1964 Jul 10.5	85.0 84.99	90.95 89.60	6697 6631	176 173	462 332	0.021 0.012	- 56
D Fragment 1964-32B											
D Cosmos 33 1964-33A	1964 June 23.43 7.93 days 1964 July 1.36	-	-	1964 June 23.6	65.0	89.50	6629	209	293	0.006	-
D Cosmos 33 1964-33B	1964 June 23.43 17.37 days 1964 July 10.80	Cylinder? 1500?	10 long? 2 dia?	1964 June 23.8	65.08	89.54	6630	219	285	0.005	42
D Fragments 1964-33C-D											
D Cosmos 34 1964-34A	1964 July 1.47 7.93 days 1964 July 9.40	-	-	1964 July 3.4	64.89	89.98	6653	202	348	0.011	37
D Cosmos 34 1964-34B	1964 July 1.47 13.89 days 1964 July 15.36	Cylinder? 1500?	10 long? 2 dia?	1964 July 5.4	64.89	89.80	6644	193	339	0.011	24

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Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg.)	Nodal period (min.)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg.)
[Thor Agena D] 1964-35A	1964 Jul 3.06 7 years	Cylinder 1500?	8 long? 1.5 dia	1964 Jul 5.5 1964 Nov 25.3	82.09 82.08	94.94 94.92	6893 6892	501 495	529 532	0.002 0.003	228 111
[Atlas Agena D] 1964-36A	1964 Jul 6.91 2.0 days 1964 Jul 8.9	Cylinder 2000?	8 long? 1.5 dia	1964 Jul 7.4	92.89	89.20	6612	121	346	0.017	145
Capsule 1964-36B	1964 Jul 6.91 180.21 days (1965 Jan 3.12)	-	-	1964 Jul 8.5 1964 Nov 26.2	92.97 92.93	91.2 90.31	6715 6666	297 261	377 314	0.006 0.004	253 42
Fragment 1964-36C											
[Thor Agena D] 1964-37A	1964 Jul 10.97 26.52 days 1964 Aug 6.49	Cylinder 1500?	8 long? 1.5 dia	1964 Jul 13.4	84.98	91.00	6699	180	461	0.021	133
Elektron 3 1964-38A	1964 Jul 10.91 200 years?	Cylinder and 6 paddles 400?	3 long? 2 dia?	1964 Jul 14.3	60.79	168.17	10093	404	7025	0.328	61
Elektron 4 1964-38B	1964 Jul 10.91 10 years?	Cone-cylinder 550?	5 long? 2 dia?	1964 Jul 14.5	60.80	1313.63	39737	457	66261	0.828	70
Elektron 4 rocket 1964-38D	1964 Jul 10.91 10 years?	Cylinder? 1500?	10 long? 2 dia?	1964 Jul 15.9	60.96	1341.37	40289	471	67350	0.830	71
Fragment 1964-38C											

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## Year of launch 1964, continued

	Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
D R?	Cosmos 35 1964-39A	1964 Jul 15.48 7.92 days 1964 Jul 23.40	-	-	1964 Jul 16.2	51.24	89.2	6616	218	258	0.003	23
D	Cosmos 35 rocket	1964 Jul 15.48 17.32 days 1964 Aug 1.80	Cylinder? 1500?	10 long? 2 dia?	1964 Jul 16.3	51.32	89.40	6627	216	282	0.005	130
	Fragments 1964-39C-D											
	[Atlas Agena] (Vela 3?)	1964 Jul 17.35 >million years	Cylinder?	9 long? 1.5 dia?	1964 Jul 17.4 1964 Dec 15.5	39.58 39.13	6022.6 6091.5	109653 110487	101959 103048	104591 105169	0.012 0.010	149 -
	Vela 4?	1964 Jul 17.35 >million years	Icosahedron 234	1.0 dia	1964 Jul 17.4 1964 Dec 15.5	40.88 40.90	6007.0 6070.5	109462 110233	94436 94584	111775 113125	0.079 0.084	74 -
T	TTS 1964-40C	1964 Jul 17.35 10 years?	Tetrahedron 2.0	0.2 side	1964 Jul 17.4 1964 Oct 24.9	36.7 38.6	2364 2350	58988 58555	220 590	105000 103764	0.888 0.881	147 159
	Cosmos 36 1964-42A	1964 Jul 30.15 7 months	Ellipsoid 400?	1.8 long? 1.2 dia?	1964 Aug 2.4 1964 Dec 8.9	49.00 48.99	91.85 90.86	6747 6698	261 239	477 400	0.016 0.012	127 22
D	Cosmos 36 rocket	1964 Jul 30.15 121.98 days 1964 Nov 29.13	Cylinder? 1500?	10 long? 2 dia?	1964 Aug 4.7 1964 Oct 7.4 1964 Nov 24.0	49.02 49.00 48.99	91.83 91.12 89.22	6746 6710 6617	254 245 212	482 419 265	0.017 0.013 0.004	143 85 328

Space vehicle: Ranger 7, 1964-41

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[illegible]

Year of launch 1964, continued

	Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
D	Cosmos 38 1964-46A	1964 Aug 18.39 82.4 days	-	-	1964 Aug 18.8	56.12	94.31	6866	206	769	0.041	60
		1964 Nov 8.8	-	-	1964 Oct 3.5	56.13	92.17	6760	193	571	0.028	157
			-	-	1964 Nov 1.4	56.09	89.70	6641	190	336	0.011	233
D	Cosmos 39 1964-46B	1964 Aug 18.39 91.14 days	-	-	1964 Aug 18.8	56.10	94.59	6880	206	798	0.043	61
		1964 Nov 17.53	-	-	1964 Oct 12.4	56.10	91.93	6751	197	548	0.026	177
			-	-	1964 Nov 11.4	56.10	89.52	6631	186	319	0.010	254
D	Cosmos 40 1964-46C	1964 Aug 18.39 92.50 days	-	-	1964 Aug 19.7	56.12	93.95	6851	206	740	0.039	61
		1964 Nov 18.89	-	-	1964 Oct 5.6	56.10	92.07	6757	196	561	0.027	162
			-	-	1964 Nov 9.5	56.10	89.74	6643	185	345	0.012	247
	Cosmos 38 rocket	1964 Aug 18.39 6 months	-	-	1964 Aug 19.8	56.12	95.13	6908	212	848	0.046	64
			-	-	1964 Dec 11.5	56.15	92.51	6778	210	590	0.028	304
			-	-								
D	Fragments 1964-46E-G											
T	Syncom 3 1964-47A	1964 Aug 19.51 > million years	Cylinder about 30	0.39 long 0.71 dia	1964 Aug 22.2	0.10	1407.8	41609	34191	36271	0.025	117
					1964 Dec 15.5	0.07	1436.5	42177	35790	35799	0	-
	Syncom 3 rocket	1964 Aug 19.51 100 000 years	Cylinder 24	1.5 long 0.46 dia	1964 Aug 20.2	16.70	698.83	25914	1137	37935	0.710	181
	Starf Lash 1B [Agena]	1964 Aug 21.66 6 months	Cylinder 1500?	8 long? 1.5 dia	1964 Aug 25.6	115.0	91.60	6734	349	363	0.001	108
					1964 Dec 5.5	115.0	90.90	6697	305	332	0.002	50

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[illegible]

## Year of launch 1964, continued

	Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclination (deg)	Nodal period (min)	Semi-major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccentricity	Argument of perigee (deg)
T	Nimbus 1	1964 Aug 28.39 20 years	Conical skeleton + 2 paddles 376	2.85 long 1.45 dia	1964 Aug 28.8	98.66	98.42	7061	429	937	0.036	158
	Nimbus 1 rocket	1964 Aug 28.39 10 years	Cylinder 1000?	6 long 1.5 dia	1964 Sept 15.5	98.68	98.40	7060	429	934	0.036	-
T	Cosmos 44	1964 Aug 28.68 100 years?	-	-	1964 Aug 29.3	65.04	99.48	7114	615	857	0.017	23
	Cosmos 44 rocket	1964 Aug 28.68 50 years	Cylinder? 1500?	10 long? 2 dia?	1964 Aug 30.1	65.05	99.54	7117	682	796	0.008	45
T	OGO 1	1964 Sept 5.92 2 years?	Box + booms 487	1.82 long 0.91 wide 0.91 high	1964 Sept 7.8 1964 Nov 13.4	31.15 33.02	3838.8 3841.4	81211 81251	281 1503	155763 148242	0.918 0.903	313 319
	OGO 1 rocket	1964 Sept 5.92 2 years?	Cylinder 1000?	6 long 1.5 dia	Orbit similar to 1964-54A							
D R?	Cosmos 45	1964 Sept 13.41 4.9 days 1964 Sept 18.3	-	-	1964 Sept 14.6	64.89	89.68	6638	207	313	0.008	36
D	Cosmos 45 rocket	1964 Sept 13.41 14.45 days 1964 Sept 27.86	Cylinder? 1500?	10 long? 2 dia?	1964 Sept 14.5	64.88	89.60	6634	203	309	0.008	36
D	[Thor Agena]	1964 Sept 14.95 21.7 days 1964 Oct 6.7	Cylinder 1500?	8 long? 1.5 dia	1964 Sept 16.1	84.96	90.88	6697	238	466	0.022	135
D	Fragment	1964-56B										



## Year of launch 1964, continued

	Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
D	Saturn SA 7	1964-57A 1964 Sept 18.68 3.86 days 1964 Sept 22.54	Cylinder 16700	24.4 long 5.5 dia	1964 Sept 20.3	31.72	88.30	6568	178	203	0.002	142
D	[Atlas Agena]	1964-58A 1964 Sept 23.84 4.78 days 1964 Sept 28.62	Cylinder 2000?	8 long? 1.5 dia	1964 Sept 25.2	92.91	89.00	6602	145	303	0.012	173
D	Fragment	1964-58B	-	-	1964 Sept 25.5	51.25	89.22	6616	211	264	0.004	16
D R?	Cosmos 46	1964-59A 1964 Sept 24.50 8.02 days 1964 Oct 2.52	-	-	1964 Sept 25.5	51.27	89.40	6624	234	259	0.002	125
D	Cosmos 46 rocket	1964-59B 1964 Sept 24.50 13.22 days 1964 Oct 7.72	Cylinder? 1500?	10 long? 2 dia?	1964 Sept 25.5	33.53 33.77	2097 2080	54271 53971	190 362	95595 94825	0.879 0.875	133 -
T	Explorer 21 (IMP 2)	1964-60A 1964 Oct 4.16 10 years?	Octagon + 4 vanes 62	0.20 long 0.71 dia	1964 Oct 4.2 1964 Dec 15.5	Orbit similar to Explorer 21						
D	Explorer 21 rocket	1964-60B 1964 Oct 4.16 10 years?	Cylinder 24	1.5 long 0.46 dia	1964 Oct 7.3	79.97	90.75	6689	182	440	0.019	158
D	[Thor Agena]	1964-61A 1964 Oct 5.91 20.50 days 1964 Oct 26.41	Cylinder 1500?	8 long? 1.5 dia	1964 Oct 7.3							

## Year of launch 1964, continued

	Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
D R?	Cosmos 47 1964-62A	1964 Oct 6.30 1.0 days 1964 Oct 7.3	-	-	1964 Oct 6.7	64.62	90.07	6657	174	383	0.016	72
D	Cosmos 47 rocket 1964-62B	1964 Oct 6.30 7.9 days 1964 Oct 14.2	Cylinder? 1500?	10 long? 2 dia?	1964 Oct 7.2	64.71	89.92	6649	168	373	0.015	67
D	Fragments 1964-62C-E											
	Ablestar rocket 1964-63A	1964 Oct 6.70 1500 years	Cylinder 450?	5.3 long 1.4 dia	1964 Oct 12.1	89.91	106.65	7448	1055	1085	0.002	35
T?	[Thor Ablestar] 1964-63B	1964 Oct 6.70 1000 years	-	-	1964 Dec 21.2	89.92	106.65	7448	1055	1085	0.002	156
T	[Thor Ablestar] 1964-63C	1964 Oct 6.70 1000 years	-	-	1964 Oct 13.0	89.93	106.63	7447	1054	1084	0.002	29
T	[Thor Ablestar] 1964-63E	1964 Oct 6.70 1000 years	-	-	1964 Oct 14.5	89.97	106.66	7449	1056	1086	0.002	32
	Fragments 1964-63D,F											
T	Explorer 22 (beacon) 1964-64A	1964 Oct 10.13 2000 years	Octagon 52	0.30 long 0.46 dia	1964 Oct 10.1	79.69	104.70	7359	885	1077	0.013	146
	Explorer 22 rocket 1964-64B	1964 Oct 10.13 300 years	Cylinder 24	1.5 long 0.46 dia	1964 Oct 20.9	79.69	104.75	7362	888	1079	0.013	119

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## Year of launch 1964, continued

	Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
T	Cosmos 49	1964-69A 1964 Oct 24.22 14 months	Ellipsoid 400?	1.8 long? 1.2 dia?	1964 Oct 24.7 1964 Dec 16.4	48.99 48.94	91.78 91.60	6743 6734	264 255	466 457	0.015 0.015	117 7
	Cosmos 49 rocket	1964-69B 1964 Oct 24.22 109.46 days (1965 Feb. 10.68)	Cylinder? 1500?	10 long? 2 dia?	1964 Oct 24.7 1964 Dec 3.4	48.94 48.93	91.81 91.26	6746 6717	260 251	477 426	0.016 0.013	117 306
D	Fragment	1964-69C	-	-	1964 Oct 29.7	51.23	88.67	6588	190	230	0.003	312
D	Cosmos 50	1964-70A 1964 Oct 28.45 8.0 days 1964 Nov 5.5	-	-	1964 Oct 29.7	51.24	88.86	6592	187	240	0.004	192
D	Cosmos 50 rocket	1964-70B 1964 Oct 28.45 4.7 days 1964 Nov 2.2	Cylinder? 1500?	10 long? 2 dia?	1964 Oct 29.7	79.95	90.70	6692	180	448	0.020	155
D	Fragments	1964-70C-D	-	-	1964 Oct 29.7	82.00	95.05	6897	512	526	0.001	303
D	[Thor Agena]	1964-71A 1964 Nov 2.89 25.34 days 1964 Nov 28.23	Cylinder 1500?	8 long? 1.5 dia	1964 Nov 3.6	79.95	90.70	6692	180	448	0.020	155
T?	[Thor Agena]	1964-72A 1964 Nov 4.09 7 years	Cylinder 1500?	8 long? 1.5 dia	1964 Nov 5.1	82.00	95.05	6897	512	526	0.001	303
	Fragments	1964-72B-D	-	-	1964 Nov 5.1	82.00	95.05	6897	512	526	0.001	303

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## Year of launch 1964, continued

	Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min)	Semi- Major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
T	Explorer 23	1964-74A	1964 Nov 6.50 50 years	Cylinder 134	2.3 long 0.62 dia	1964 Nov 6.51	51.95	7100	466	977	0.036	138
D	[Thor Agena]	1964-75A	1964 Nov 18.90 17.41 days 1964 Dec 6.31	Cylinder 1500?	8 long? 1.5 dia	1964 Nov 21.70	70.02	6638	180	339	0.012	100
T	Explorer 24	1964-76A	1964 Nov 21.71 5 years?	Inflated sphere 8.6	3.65 dia	1964 Nov 21.79	81.36	7889	525	2498	0.125	166
T	Explorer 25 (Injun 4)	1964-76B	1964 Nov 21.71 200 years	Sphere 40	0.61 dia	1964 Nov 21.79	81.36	7886	522	2494	0.125	166
	Explorer 24 rocket	1964-76C	1964 Nov 21.71 100 years	Cylinder 23	1.5 long 0.46 dia	1964 Dec 15.5	81.36	7891	531	2495	0.124	-
	Fragments	1964-76D-J										
D	Zond 2 launcher	1964-78A	1964 Nov 30.55 1.23 days 1964 Dec 1.78	-	-	1964 Nov 30.9	64.72	6564	153	219	0.005	313
D	Zond 2 rocket	1964-78B	1964 Nov 30.55 2.10 days 1964 Dec 2.65	-	-	1964 Dec 1.5	64.73	6562	177	190	0.001	317
D	[Atlas Agena]	1964-79A	1964 Dec 4.79 1.2 days 1964 Dec 6.0	Cylinder 2000?	8 long? 1.5 dia	1964 Dec 5.2	97.02	6636	158	357	0.015	-

Space Vehicles: Mariner 3, 1964-73; Mariner 4, 1964-77; Zond 2, 1964-78C.

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## Year of launch 1964, continued

Name	Launch date, lifetime and descent date	Shape and weight (kg)	Size (m)	Date of orbital determination	Orbital inclina- tion (deg)	Nodal period (min)	Semi- major axis (km)	Perigee height (km)	Apogee height (km)	Orbital eccen- tricity	Argument of perigee (deg)
T San Marco 1	1964-84A	1964 Dec 15.85 8 months	Sphere 115	0.66 dia	1964 Dec 16.9	37.77	94.94	198	846	0.047	113
San Marco rocket	1964-84B	1964 Dec 15.85 53.2 days (1965 Feb 7.1)	Cylinder 24	1.5 long 0.46 dia	1964 Dec 31.5	37.80	93.5	194	697	0.037	-
Fragment [Thor Agena]	1964-84C 1964-85A	1964 Dec 19.88 26.06 days (1965 Jan 14.94)	Cylinder 1500?	8 long? 1.5 dia	1964 Dec 22.9	74.97	90.46	183	410	0.017	153
Explorer 26	1964-86A	1964 Dec 21.38 10 years?	Octagon + 4 vanes 46	0.43 long 0.71 dia	1964 Dec 21.4	20.14	456.26	316	26191	0.659	121
Explorer 26 rocket	1964-86B	1964 Dec 21.38 10 years?	Cylinder 23	1.5 long 0.46 dia	orbit similar to 1964-86A						
[Thor Agena]	1964-87A	1964 Dec 21.80 21.64 days (1965 Jan 11.44)	Cylinder 1500?	8 long? 1.5 dia	1964 Dec 25.1	70.08	89.5	238	264	0.002	111

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" 4	1962 $\xi 1$	20	" 8	1959 $\lambda$	4
" 5	1962 $\eta$	21	" 11	1960 $\delta$	5
" 6	1962 $\alpha\delta 1$	23	" 13	1960 $\theta$	7
" 7	1962 $\alpha\iota 1$	24	" 14	1960 $\kappa$	8
" 8	1962 $\alpha\xi 1$	25	" 15	1960 $\mu$	8
" 9	1962 $\alpha\omega 1$	26	" 17	1960 $\omicron$	9
" 10	1962 $\beta\zeta 1$	27	" 18	1960 $\sigma$	9
" 11	1962 $\beta\theta 1$	28	" 19	1960 $\tau$	9
" 12	1962 $\beta\omega 1$	31	" 20	1961 $\varepsilon 1$	11
" 13	1963-6A	32	" 21	1961 $\zeta$	11
" 14	1963-10A	33	" 23	1961 $\lambda 1$	12
" 15	1963-11A	33	" 25	1961 $\xi 1$	13
" 16	1963-12A	34	" 26	1961 $\pi$	13
" 17	1963-17A	35	" 29	1961 $\psi$	15
" 18	1963-18A	35	" 30	1961 $\omega$	15
" 19	1963-33A	39	" 31	1961 $\alpha\beta$	15
" 20	1963-40A	40	" 32	1961 $\alpha\gamma 1$	15
" 21	1963-44A	41	" 34	1961 $\alpha\varepsilon 1$	16
" 22	1963-45A	42	" 35	1961 $\alpha\zeta 1$	16
" 23	1963-50A	43	" 36	1961 $\alpha\kappa 1$	17
" 24	1963-52A	43	" 37	1962 $\delta$	18
" 25	1964-10A	47	" 38	1962 $\varepsilon$	18
" 26	1964-13A	48			
" 27	1964-14A	48			
" 28	1964-17A	49	Echo 1	1960 $\iota 1$	7
" 29	1964-21A	50	" 2	1964-4A	46
" 30	1964-23A	51	Electron 1	1964-6A	46
" 31	1964-28A	52	" 2	1964-6B	46
" 32	1964-29A	52	" 3	1964-38A	54
" 33	1964-33A	53	" 4	1964-38B	54
" 34	1964-34A	53	Explorer 1	1958 $\alpha$	2
" 35	1964-39A	55	" 3	1958 $\gamma$	2
" 36	1964-42A	55	" 4	1958 $\varepsilon$	2
" 37	1964-44A	56	" 6	1959 $\delta 1$	3
" 38	1964-46A	57	" 7	1959 $\iota 1$	4
" 39	1964-46B	57	" 8	1960 $\xi 1$	8
" 40	1964-46C	57	" 9	1961 $\delta 1$	11
" 41	1964-49D	58	" 10	1961 $\kappa 1$	12
" 42	1964-50A	58	" 11	1961 $\nu$	13
" 43	1964-50C	58	" 12	1961 $\upsilon$	14



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Explorer 13	1961 $\chi$	15	Needles	1963-14J	34
" 14	1962 $\beta\gamma 1$	27	Nimbus 1	1964-52A	59
" 15	1962 $\beta\lambda 1$	28			
" 16	1962 $\beta\chi$	31	Ogo	1964-54A	59
" 17	1963-9A	33	Oscar 1	1961 $\alpha\kappa 2$	17
" 18	1963-46A	42	Oscar 2	1962 $\chi 2$	22
" 19	1963-53A	44	Oso 1	1962 $\zeta 1$	18
" 20	1964-51A	58			
" 21	1964-60A	60			
" 22	1964-64A	61			
" 23	1964-74A	64	Polyot 1	1963-43A	41
" 24	1964-76A	64	Polyot 2	1964-19B	50
" 25	1964-76B	64			
" 26	1964-86A	66			
Faith 7	1963-15A	35	Radiation Sat.	1963-38C	40
Friendship 7	1962 $\gamma 1$	18	" "	1964-83C	65
			Radose	1963-21D	36
Gemini 1	1964-18A	50	Ranger 1	1961 $\phi 1$	14
GGSE	1964-1B	45	" 2	1961 $\alpha\theta$	17
Greb 1	1960 $\eta 2$	7	Relay 1	1962 $\beta v 1$	30
Greb 3	1961 $\alpha 2$	13	" 2	1964-3A	45
GRS	1963-26A	37			
Hitchhiker	1963-25B	37	Samos 2	1961 $\alpha 1$	10
			San Marco 1	1964-84A	66
Imp 1	1963-46A	42	Saturn SA5	1964-5A	46
Imp 2	1964-60A	60	" SA6	1964-25A	51
Injun 1	1961 $\alpha 2$	13	" SA7	1964-57A	60
Injun 3	1962 $\beta\tau 2$	30	Secor	1964-1C	45
Injun 4	1964-76B	64	Sigma 7	1962 $\beta\delta 1$	27
			Sputnik 1	1957 $\alpha 2$	1
Lofti 1	1961 $\eta$	11	" 2	1957 $\beta 1$	1
Lofti 2A	1963-21B	36	" 3	1958 $\delta 2$	2
Luna 4	1963-8A	33	" 4	1960 $\epsilon 1$	6
Lunik 3	1959 $\theta$	4	" 5	1960 $\lambda 1$	8
			" 6	1960 $\rho 1$	9
Mars 1	1962 $\beta v 1$	28	" 7	1961 $\beta 1$	10
Mercury 4	1961 $\alpha\alpha 1$	15	" 8	1961 $\gamma 1$	10
" 5	1961 $\alpha v 1$	17	" 9	1961 $\theta 1$	11
" 6	1962 $\gamma 1$	18	" 10	1961 $\iota 1$	12
" 7	1962 $\tau 1$	21	" 19	1962 $\alpha\pi 1$	25
" 8	1962 $\beta\delta 1$	27	" 20	1962 $\alpha\tau 1$	25
" 9	1963-15A	35	" 21	1962 $\alpha\phi 1$	26
Midas 2	1960 $\zeta 1$	6	" 22	1962 $\beta i 1$	28
" 3	1961 $\sigma 1$	14	" 23	1962 $\beta v 1$	28
" 4	1961 $\alpha\delta 1$	16	" 24	1962 $\beta\epsilon 1$	29
" 5	1962 $\kappa 1$	19	" 25	1963-1A	32
" 6	1963-14A	34	" 26	1963-8C	33
" 7	1963-30A	38	SR 4	1963-21C	36
			SR 5	1964-1D	45
			Starflash 1A	1964-30A	52
			Starflash 1B	1964-48A	57
			Star-rad	1962 $\beta\kappa$	28
			Surcal	1963-21F	36
			Syncom 1	1963-4A	32
			" 2	1963-31A	38
			" 3	1964-47A	57

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Telstar 1	1962 $\alpha\epsilon 1$	23
" 2	1963-13A	34
Tiros 1	1960- $\beta 2$	5
" 2	1960 $\pi 1$	9
" 3	1961 $\rho 1$	14
" 4	1962 $\beta 1$	18
" 5	1962 $\alpha\alpha 1$	22
" 6	1962 $\alpha\psi 1$	26
" 7	1963-24A	37
" 8	1963-54A	44
Titan 3A	1964-81A	65
Traac	1961 $\alpha\eta 2$	16
Transit 1B	1960 $\gamma 2$	5
" 2A	1960 $\eta 1$	7
" 3B	1961 $\eta$	11
" 4A	1961 $\sigma 1$	13
" 4B	1961 $\alpha\eta 1$	16
" 5A	1962 $\beta\psi 1$	31
"	1963-22A	36
"	1963-49C	43
"	1964-83D	66
TRS 1A	1963-14B	34
" 1B	1963-14C	34
" 1C	1963-30B	38
" 2	1963-39B	40
"	1964-40C	55
Vanguard 1	1958 $\beta 2$	2
" 2	1959 $\alpha 1$	3
" 3	1959 $\eta 1$	4
Vela 1	1963-39A	40
" 2	1963-39C	40
" 3	1964-40A	55
" 4	1964-40B	55
Venus Probe	1961 $\gamma 1$	10
Voskhod 1	1964-65A	62
Vostok 1	1961 $\mu 1$	13
" 2	1961 $\tau 1$	14
" 3	1962 $\alpha\mu 1$	24
" 4	1962 $\alpha\nu 1$	24
" 5	1963-20A	36
" 6	1963-23A	37
Zond 1	1964-16	49
Zond 2	1964-78	64



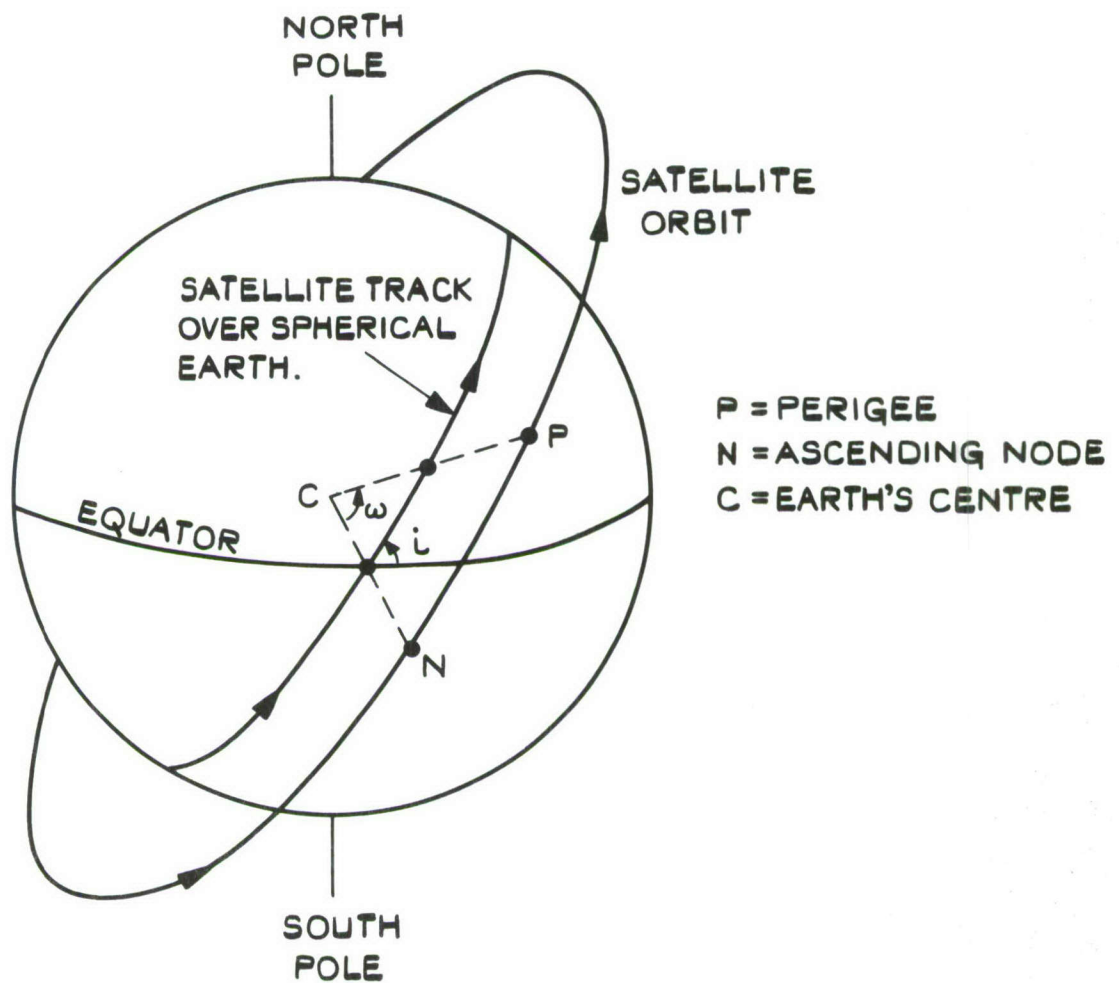


FIG. 1 DIAGRAM SHOWING DEFINITION OF INCLINATION  $i$  AND ARGUMENT OF PERIGEE  $\omega$ .